

				•
*				

		÷			
		¥			
	. 3				
	· ·				
	· · · · · · · · · · · · · · · · · · ·				
	•	N .	,		
	•				
٠.					

# Journal of Conchology

(Established 1874)

Vol 36, Part 1. December 1997

Conchological Society of Great Britain and Ireland

## CONCHOLOGICAL SOCIETY OF GREAT BRITAIN AND IRELAND

HON. SECRETARY Ms. J. Reynolds, 21c Loraine Road, Holloway, London N7 6EZ

Hon. Treasurer & Hon. Membership Secretary Mr W.D. Weideli, 35 Bartlemy Road, Newbury, Berks. RG14 6LD

Hon. Editor Dr P.G. Oliver, National Museums & Galleries of Wales, Cathays Park, Cardiff CF1 3NP

PROGRAMME SECRETARY Dr R. Honnor, "Hilliers", Frieth, Henley-on-Thames, Oxon.

Conservation Officer Dr M.J. Willing, 14 Goodwood Close, Midhurst, Sussex GU29 9JG

MARINE CENSUS RECORDER Mrs J. Light, 88 Peperharow Road, Godalming, Guildford, Surrey GU7 2PN

Non-marine Census Recorder Dr M.P. Kerney, Department of Zoology, British Museum (Natural History), Cromwell Road, London SW7 5BGD

NEWSLETTER EDITOR Miss R.E. Hill, 447B Wokingham Road, Earley, Reading RG6 2EL

Member's subscription £23 per annum. Entrance fee £1.

FAMILY MEMBERSHIP £25 per annum.

Institutional membership £32 (UK rate); £37 (overseas\*) per annum.

STUDENT'S MEMBERSHIP £10 per annum.

\*Overseas members are reminded that all monies due to the Society are payable in sterling

PUBLICATIONS Members receive:

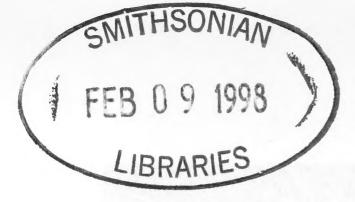
The Journal of Conchology (usually two numbers a year)

The Conchologists' Newsletter (quarterly)

For back-numbers of these publications and special numbers please apply to: Mr Weideli, 35 Bartlemy Road, Newbury, Berks. RG14 6LD

MEETINGS are held at the British Museum (Natural History) at 2.30pm usually on the third Saturday of each month from October to May. Field meetings are held in the summer.

© Conchological Society of Great Britain and Ireland Printed by Henry Ling, The Dorset Press, Dorchester DT1 1HD



# NEW SPECIES AND RECORDS OF RASTAFARIA AND MEGAXINUS (BIVALVIA: LUCINIDAE) FROM THE WESTERN INDIAN OCEAN AND RED SEA, WITH A REAPPRAISAL OF MEGAXINUS

Emily A. Glover<sup>1</sup> & John D. Taylor<sup>1</sup>

Abstract A new species of the lucinid bivalve genus Rastafaria is described from the Western Indian Ocean and Red Sea. This differs from the type and previously only known species R. thiophila from Western Australia, in being larger, more rounded in outline and with a shorter, less sunken, anterior dorsal area. Additionally, three species of Megaxinus, two new, are described from the Indian Ocean. These are the first records of the genus in the Indian Ocean. Other species of Megaxinus are found in the Mediterranean and western Atlantic and in Miocene to Pliocene deposits of western Europe. These other living species of Megaxinus and some of the closely related fossil species are briefly reviewed.

Key words Bivalvia, Lucinidae, Systematics, Indian Ocean.

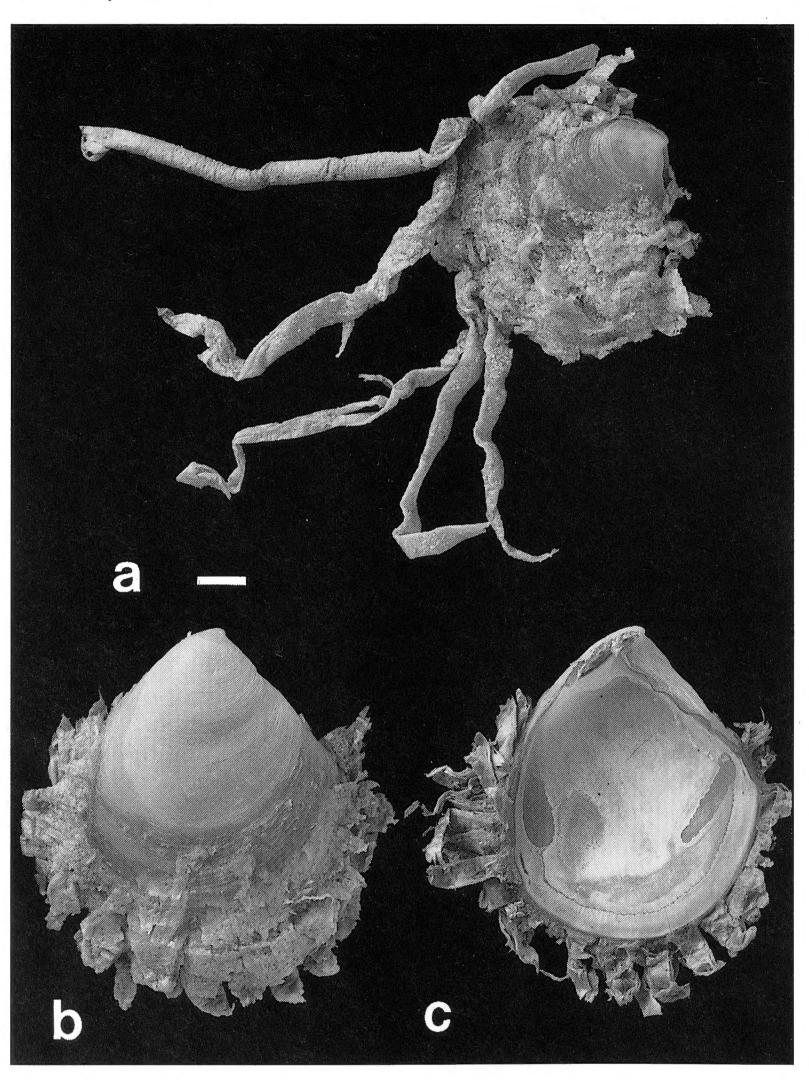
#### INTRODUCTION

Since the discovery of their chemosymbiosis with sulphur-oxidising bacteria, the biology of lucinid bivalves has been the focus of much attention. Much work has beendone on the nature and chemistry of the symbiosis and this has gone some way to explain the frequent presence and abundance of lucinids in unusual habitats such as anoxic black muds, areas of high organic enrichment as in seagrass beds and mangroves and the recently-discovered cold seeps and oxygen minimum zones (reviews by Fisher 1990; Reid 1990; Hickman 1994; Le Pennec, Beninger & Herry 1995). The association of lucinids with these environments has also been recognised in fossil faunas (Taviani 1994; Kauffman, Arthur, Howe & Scholle 1996). Despite this burgeoning biological activity, the systematics of Lucinidae have been relatively neglected at all levels, with many supraspecific taxa being rather poorly defined. For example, in the most recent revisions of the Lucinidae, Chavan (1969) and Bretsky (1976) differ considerably in their treatment of *Megaxinus*, one of the subjects of this paper. It is also apparent that in the tropics at least, lucinids are much more diverse than previously realised (von Cosel & Bouchet, in press; Taylor & Glover, in press).

Recently, a remarkable new lucinid bivalve, *Rastafaria thiophila* Taylor and Glover, 1997, was discovered around the Houtman Abrolhos Islands, Western Australia. This species possesses long pipes of periostracal material which radiate from the ventral margin of the shell (Fig. 1). In common with most other Lucinidae, the ctenidia of *R. thiophila* house sulphur-oxidising chemosymbiotic bacteria and the periostracal pipes are thought to function as conduits bringing sulphide-rich interstitial water into the mantle cavity (Taylor & Glover, 1997). Apart from the distinctive periostracal features, the shell of *R. thiophila* is subtrigonal, edentulous and similar in general characters to some species classified as *Megaxinus* Brugnone, 1880. Species of this genus are common in the Neogene of southern Europe (Sacco, 1901). However, the few living species are rather poorly known and prior to this publication were recorded only from the eastern Atlantic and Mediterranean (van Aartsen & Carrozza, 1992).

Since the description of Rastafaria thiophila, we have found specimens, unfortunately

<sup>&</sup>lt;sup>1</sup> Dept. of Zoology, The Natural History Museum, Cromwell Rd, London SW7 5BD, UK



**Fig. 1** *Rastafaria thiophila* Taylor and Glover, 1997 **a** Holotype, WAM 44-95, Houtman Abrolhos Islands, Western Australia. Scale bar = 5 mm. **b–c** Paratype BMNH 1995085, exterior of right valve and interior of left valve.

all of dead shells, of another undescribed species in collections of the Muséum National d'Histoire Naturelle, Paris and the Academy of Natural Sciences, Philadelphia. In addition, Graham Oliver (National Museum of Wales) has passed on material of this same species recently collected in the northern Red Sea. A single shell of the undescribed species from Nuweiba, Sinai was illustrated by Taylor and Glover (1997, Figs 16–17). In addition, we describe two new species of *Megaxinus* from the Indian Ocean, recognise *Cryptodon omanensis* Smith, 1906 from the Gulf of Oman as a *Megaxinus*, and redescribe it using additional material from the John Murray Expedition to the Indian Ocean (1933–34), housed in the Natural History Museum, London. A shell of this species was illustrated as *Megaxinus* sp. (Taylor & Glover, 1997, Figs 12–13). We also briefly review the other living species of *Megaxinus* from the Mediterranean and eastern Atlantic, and

consider some of the closely related fossil species.

Institutional abbreviations:

AM Australian Museum, Sydney

BMNH The Natural History Museum, London

MNHN Muséum National d'Histoire Naturelle, Paris NMW National Museum of Wales, Cardiff - Pre 1970 NMW.Z National Museum of Wales, Cardiff - Post 1970

SMF Senckenbergischen Naturforschenden Gesellshaft, Frankfurt

WAM Western Australian Museum, Perth

#### SYSTEMATIC DESCRIPTIONS

#### LUCINOIDEA LUCINIDAE

Genus *Rastafaria* Taylor & Glover, 1997 Type species *Rastafaria thiophila* Taylor & Glover, 1997

Diagnosis Shell thin, compressed, subtrigonal, higher than long (Fig.1) Beaks conspicuous, elevated, pointed and curve over antero-dorsal area. Large sunken, elongate, antero-dorsal area, incorporating lunule. Shell exterior dull, with fine concentric ridges and more or less covered by a thick, shaggy periostracum. The periostracum is extended as up to seven ribbon-like pipes from around the ventral margin in the type species. The hinge plate is wide, edentulous and with rounded folds on the anterior inner margin. Ligament opisthodetic, external. The inner shell margin is smooth. Anterior adductor muscle scar elongate and mainly detached from pallial line, from which it diverges posteriorly at an angle of about 35°.

Remarks Although Rastafaria and Megaxinus share some characters such as the absence of hinge teeth, no trace of the distinctive periostracal pipes has been seen on any living Megaxinus species. In contrast, preserved specimens of M. unguiculinus from Greece had a broad, stiff, transparent periostracum which formed an even-sized band at the shell margin. In one specimen the successive periostracal bands appear as corrugated fringes on the surface of the shell. In profile, Rastafaria shells are tear-drop shaped (see Figs 1 & 2), with circular ventral margins and sharply pointed umbonal area. By comparison, Megaxinus species are usually extended anteriorly and have a slightly sinuous ventral margin. The antero-dorsal area of Rastafaria is elongate and concave, but this is convex in Megaxinus.

### Rastafaria calypso n. sp. Figs 2 & 3a–c

Holotype H 40.0 mm, L 36.5 mm, T 7.4 mm, Arabian Gulf, 70 m, MNHN.

*Paratypes* 2sh, H 45.1 mm, L 45.0 mm, T 8.7 mm (single valve) and H 40.5 mm, L 38.5 mm, T 8.0 mm, 2 left valves H 32.5 mm, L 31.6 mm, T 5.0 mm and H 34.5 mm, L 30.0 mm, T 6.5 mm and 1 right valve H 40.2 mm, 38.5 mm, T 8.0 mm, Arabian Gulf, 70 m, MNHN.

Type locality Arabian Gulf, 70 m, no further details, Coll. G. Cherbonnier 1954, N.O.

**Fig. 2** *Rastafaria calypso* new species. **a–b** Holotype, MNHN, Arabian Gulf. Exterior and interior of left valve. Height = 40.0 mm. **c** Paratype, MNHN, Arabian Gulf. Exterior of right valve showing radial plications in the ventral margin which may indicate the position of the periostracal extensions. Height = 45.1 mm. **d** Hurghada, Red Sea, NMWZ 1997.017.3. Exterior of left valve showing shallow radial folds along the ventral margin. Height = 28.3 mm. **e** Paratype, MNHN, Arabian Gulf, interior of left valve of a thin-shelled "younger" animal than Fig. 2 a-c. Height = 40.2 mm.

Calypso.

Other material examined Red Sea 47 rv, 40 lv + 13 juvenile sh, Bay of Safaga, south of Hurghada, Egypt, 20–39 m NMW.Z.1997.017.1, BMNH and Department of Palaeontology, University of Vienna. 2v, Nuweiba, Sinai, AM C141952. Gulf of Aden 3v, Meteor station M31/2 93/10 20°57.53′N, 37°22.14′E, 56 m Insitüt für Palaeontologie, University of Würtzburg. Madagascar 20v, 1 articulated sh, 2–3 miles south of Nossi Iranja, 32 miles south of Nossi Bé, 30–36 m in muddy sand ANSP 262074.

Description Shell thin in small specimens, thickened in largest individuals, relatively compressed, (mean T/L 0.20) tumidity to a maximum of 8.7 mm on a single valve. Shell subovate (mean H/L 1.02). Shell height to maximum of 45.1 mm, length to a maximum of 45.0 mm. Umbones peaked, narrow, with beaks curving over the antero-dorsal area.

Antero-dorsal area narrow, lanceolate, with fine ridges, but without a distinct lunule. Escutcheon narrow and finely ridged. Exterior sculpture consists of fine, concentric ridges. Growth lines often distinct, giving undulating surface to shell. Some specimens have irregular, radial plications in the ventral part of the shell (Fig. 2c–d). Shell covered by thick, yellowish periostracum which may be extended as a ragged fringe around most of the shell margin. Traces of the probable periostracal pipes, as seen in the type species, *Rastafaria thiophila*, were preserved only in one specimen from Madagascar (Fig. 3a).

Hinge plate thick, edentulous, sometimes with one or more folds along the anterior ventral margin. Ligament opisthodetic, narrow, external. Inner shell margin smooth, with a narrow pallial line. In younger specimens a translucent band below the pallial line marks the outcrop of a prismatic shell layer as in *R. thiophila*. Anterior adductor muscle scar elongate, with finely crenulate margins, diverging from the pallial line for most of its length. Posterior adductor muscle scar large, oval, the pallial line terminating at its ventral edge. In large specimens, the dorsal margin of the muscle scar is often irregularly dissected. Impression of pallial blood vessel is deeply incised in larger specimens and curved from umbo towards anterior margin (Fig. 2b). Internal surface of valve irregular, sometimes with radial marks of pallial muscles, and in large individuals such as the thick-shelled holotype, the inner surface maybe irregularly pitted and pustulose. Shell colour creamy white.

Juvenile shells As in many lucinids, the juvenile shell differs quite markedly from the adult in being more anteriorly extended with an almost circular outline (Fig. 2h), the anterior dorsal area more depressed (Fig. 2g). The shell is also thinner and lacks the impression of the pallial blood vessels.

*Prodissoconch* The larval shell of *R. calypso* consists of a rounded "D" shaped prodissoconch I, 200  $\mu m$  in length, without growth increments (Fig. 3c). A very thin prodissoconch II may be interposed between prodissoconch I and the dissoconch. The larval shell morphology indicates lecithotrophic development.

Variation between samples We have three samples of this species collected from widely separated locations of the Arabian Gulf, the northern Red Sea and Madagascar. Specimens from the holotype locality in the Arabian Gulf are larger, up to 45.0 mm in

f Hurghada, Red Sea. NMWZ 1997.017. Interior of right valve. Height = 29.4 mm.

**g** Hurghada, Red Sea. Detail of the hinge of a juvenile shell. Height = 3.8 mm.

**h** Hurghada, Red Sea. NMWZ 1997.017. Exterior of a juvenile shell which illustrates the typical circular outline. Height = 9.2 mm.

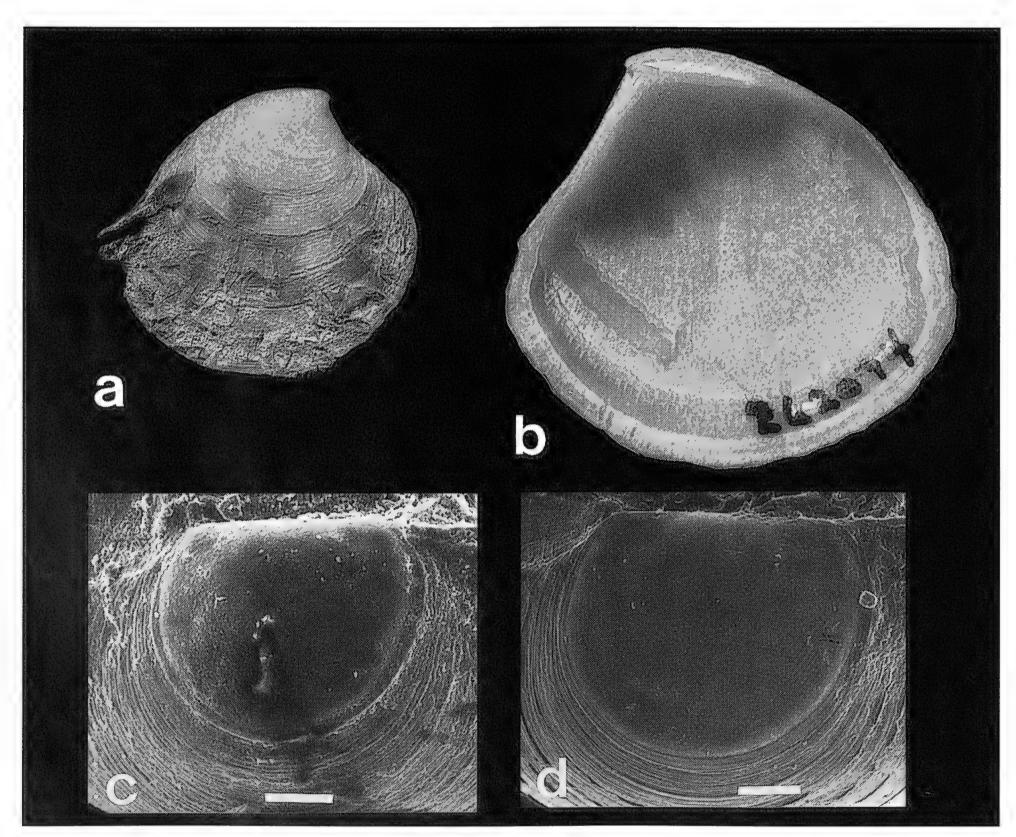
#### 6 E.A. GLOVER & J.D. TAYLOR

height compared to a maximum height of 27.0 mm of shells from the Red Sea and 28.0 mm from Madagascar. Two of the Arabian Gulf specimens, including the holotype, are also much thicker-shelled, with a deeply-incised pallial blood vessel scar and a roughened, pustulate inner shell surface. These shell characters are probably typical of older specimens. However, other specimens from the Arabian Gulf (Fig. 2e), although larger, are closely similar in shape to the specimens from both the Red Sea and Madagascar as indicated in Figs 2d & f, 3b, 4). The shells from the Red Sea and Madagascar are similar in shape, shell thickness and size.

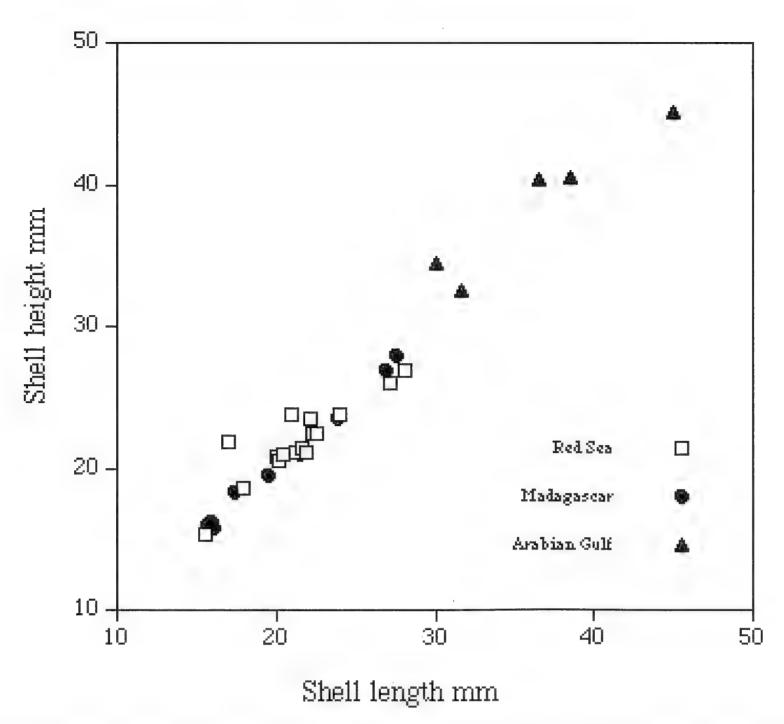
Derivation of name Named after N.O. Calypso, research vessel of Jacques Cousteau.

Habitat Animals from Madagascar were collected from 30–36 m in muddy sand. Red Sea shells from muddy and coral sands at 10 and 39 m and the Arabian Gulf sample from 70 m.

Distribution Arabian Gulf, northern Red Sea, Gulf of Aden and northwestern Madagascar.



**Figs 3a–b** *Rastafaria calypso* new species. Nossi Bé, Madagascar. ANSP 262074. **a** Exterior of right valve with the thick, shaggy periostracum preserved and the remnants of a pipe on the posterior margin of the shell. Height = 18.5 mm. **b** Interior of right valve. Height = 27.2 mm. **Fig. c** *Rastafaria calypso*, Hurghada, Red Sea, NMWZ 1997.017.3. Larval shell. Scale bar = 50 μm. **Fig. d** *Megaxinus unguiculinus* Djerba, Tunisia, MNHN. Larval shell. Scale bar = 50 μm.



**Fig. 4** Plot of height against length for specimens of *Rastafaria calypso* new species from Arabian Gulf, Red Sea and Madagascar.

Comparison with other species Rastafaria calypso differs from R. thiophila in being generally larger, with a maximum height of 45.0 mm compared to 31.7 mm in R. thiophila and with a more ovate outline, with the mean H/L 1.02 compared to 1.13 in R. thiophila. The shells of large specimens of R. calypso are also thicker and can have a heavily pustulate inner shell surface. The umbones are also less peaked compared to R. thiophila. In R. calypso the antero-dorsal area is slightly sunken, but is not as deep and open as in R. thiophila. The internal muscle scars are similar, but the anterior adductor muscle scar is proportionately longer in R. calypso particularly in the animals from Arabian Gulf, in which the mean ratio of shell length over anterior adductor muscle scar length is 0. 41 compared to 0.34 in animals from the Red Sea and Madagascar and 0.31 in R. thiophila.

The typical periostracal pipes of *R. thiophila* are not preserved in *R. calypso* although one specimen from Madagascar has remains of a thick periostracum with remnants of shrivelled pipes (Fig. 3a). The large specimens from the Arabian Gulf and Red Sea have irregular, plicate folds on the ventral part of the outer shell, which may possibly mark the position of periostracal pipes.

Genus *Megaxinus* Brugnone, 1880 Type species *Lucina transversa* Bronn, 1831 Subsequent designation Pallary (1904: 146)

There is a problem with the concept of the genus *Megaxinus*. The name was introduced by Brugnone (1880), who cited two species, *Lucina rostrata* Pecchioli, 1864 and *L. transversa* Bronn, 1831, both from the Pliocene of Italy. The first of these, *M. rostratus*, is a large thick-shelled species, while *M. transversus* is smaller, thinner shelled and quadrate.

There has been some confusion as to which is the type species (Sacco 1901; Lamy 1920; Chavan 1938, 1969; Bretsky 1976), but Pallary (1904 p.146) clearly designated L. transversa. Sacco (1901: 71) cited M. ellipticus (Borson, 1825), but this species was not amongst those listed by Brugnone. Later, Chavan (1938, 1969) ignored Pallary's designation and accepted L. rostrata as the type species, assigning L. transversa to Gibbolucina Cossmann, 1904. However, the type species of Gibbolucina, Venus callosa Lamarck, 1806, although a similar shape to M. transversus, possesses distinct cardinal teeth. Megaxinus transversus is a Pliocene fossil (Sacco 1901), but has also been widely reported living in the Mediterranean and western Atlantic (Poppe & Goto 1993; Zenetos 1996). However, we are in agreement with van Aartsen and Carrozza (1992) who show that most, if not all, Megazinus living in the Mediterranean belong to the similar species M. unguiculinus Pallary, 1904. This latter is a smaller, thin-shelled animal with deep, heart-shaped lunule, inflated and curved beaks extended over the lunule and no posterior sulcus. In comparison, M. transversus, although similar, can be distinguished by the shallower, more open lunule, the well-defined posterior sulcus and the less inflated beaks (Figs 7e, f, g, h). Following the suggestion of von Aartsen and Carrozza (1992) we agree that M. transversus is probably an extinct species.

At first sight *M. rostratus* and *M. transversus* would seem to belong to different genera. However, observations on other species suggest ontogenetic changes in shape, for example in *Megaxinus appendiculatus* (Locard 1898) from the western Atlantic. This species can reach 47 mm shell height, as in the holotype of *Cryptodon murchlandi* Sowerby, 1907, a junior synonym of *M. appendiculatus*. These larger animals are thick-shelled and relatively high, compared with the smaller, thin-shelled, more circular individuals (Fig. 7a–d). Such changes in shell thickness and shape with increasing size are similar to those seen in the Indian Ocean species *M. omanensis* described below (Figs 5 a–f). This leads us to think that *Megaxinus rostratus* and *M. transversus* could possibly be the same, the former species being a large, thick-shelled form. Certainly, ontogenetic shape changes can be seen in the growth lines of *M. rostratus* which suggest that the

juvenile shells were rounder and with a less quadrate anterior margin.

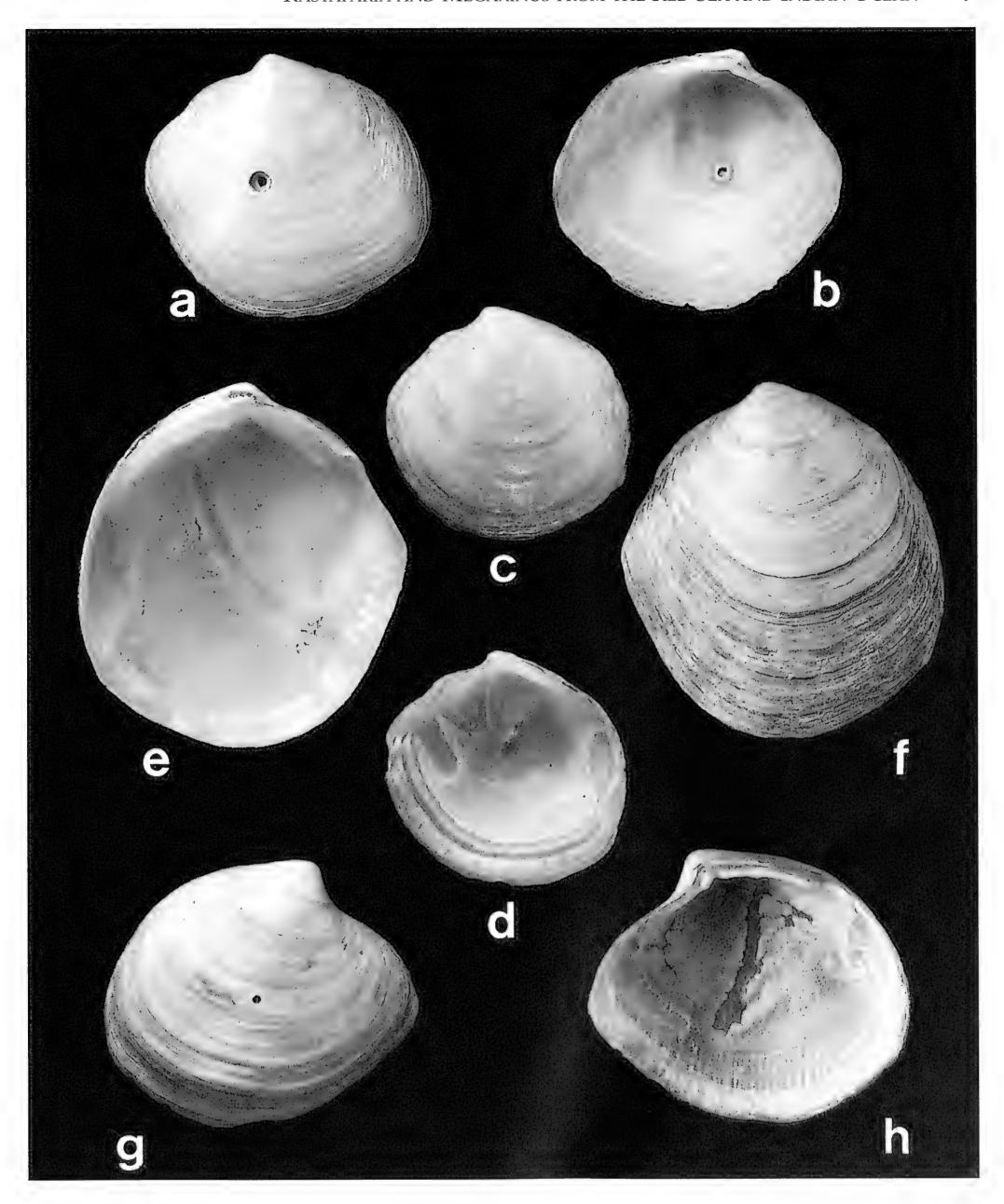
Chavan (1969: N498) ) synonymised *Stewartia* Olsson & Harbison, 1953 (type species *Lucina anodonta* Say, 1824) with *Megaxinus*. Although *Stewartia* species from the western Atlantic (*S. anodonta* and *S. floridana* Conrad, 1833) are edentulous, the shells are, however, subcircular, there is a posterior sulcus and the anterior adductor scar lies close to the pallial line. These characters all suggest that *Stewartia* species are distinct from *Megaxinus*.

Diagnosis Shell subcircular to irregularly oval to subquadrate, the anterior margin often broadly angular. Surface sculpture of concentric growth lines only. Lunule either indistinct or small and heart-shaped. Hinge often thick but without teeth and sometimes with irregular folds on anterior ventral edge of hinge plate. Anterior adductor muscle scar elongate and detached from the pallial line for about two thirds of its length. Inner shell margin smooth. In large, thick-shelled specimens the trace of the pallial blood vessel may be deeply incised and inside of the shell often irregularly pustulose.

#### INDIAN OCEAN SPECIES OF MEGAXINUS

Megaxinus omanensis Smith, 1906 Figs 5a-f

Cryptodon omanensis Smith, 1906: 257.



**Figs 5a–f** *Megaxinus omanensis* (Smith, 1906). **a–b** Paratype BMNH 1906.10.12.32. Gulf of Oman. Exterior and interior of left valve. Height = 18.6mm. **c–d** BMNH accession number 2219, Pemba Channel, Indian Ocean. John Murray Expedition Station 106, 183-194 m. Juvenile specimen, exterior of left valve and interior of right valve. Height = 16.6 mm. **e–f**. BMNH accession number 2219, Pemba Channel, Indian Ocean. Interior and exterior of the left valve. Height = 37.6 mm. **Figs g–h**. *Megaxinus arabicus* new species. Holotype NMW Z. 1995.009, Southern Oman. Exterior and interior of right valve. Height = 26.0 mm.

Holotype Zoological Survey of India, Calcutta M3783/1.

Paratype H 18.6, L 20.0, T 4.2 mm, BMNH 1906.10.12.32.

Type locality Investigator Station 341, Gulf of Oman, Indian Ocean, 230 fthms.

Other material examined Pemba Channel, East Africa, 5°38′54 S; 39°15′42 E., 183–194 m, John Murray Expedition, Station 106, BMNH accession number 2219. 1lv, H 37.5 mm, L 34.1 mm, T 9.0 mm, 1 juv. sh. (H 16.6, L 17.5, T 3.7 mm); 7 separated juv. sh., comprising 2lv (H 14.7 & 13.5 mm) + 5rv (H 24.9, 20.1, 19.4, 14.6 & 13.5 mm).

Description In the large specimen (Fig. 5e–f) the shell is thick, ovate, higher than long (H/L 1.13), moderately inflated (T/L 0.28), extended anteriorly with a distinctive quadrate outline on the antero-ventral margin. Antero-dorsal area large, convex and surrounded with a shallow groove. There is no visible lunule. The umbones are narrow and curve over the anterior margin of the shell. Escutcheon narrow. Sculpture consists of fine, irregularly spaced, concentric lirae. Traces of a creamy brown periostracum give rough appearance to ventral part of shell.

Hinge plate thick, edentulous, the posterior ventral margin of hinge has irregular folds. Ligament external, elongate in a sunken groove. Anterior adductor muscle scar elongate, joined to pallial line only at dorsal tip and detached from pallial line at an angle of about 25°. Posterior adductor scar is irregularly ovate in outline. Pallial line continuous, the shell outside the line is glossy, that within line is dull, chalky and irregularly pitted. Impression of pallial blood vessel is deeply incised, curving diagonally from the postero-dorsal area towards antero-ventral margin of the shell. Inner shell margin smooth. Shell colour white.

Juvenile shells (Figs 5a–d). These are different in shape from the adult, but the ontogenetic changes in shape can be seen in the growth increment outlines on the exterior of the large individual. Juvenile shells are subcircular in outline and slightly longer than high with a mean H/L 0.98 (n= 6, range 0.09) compared to H/L 1.13 in the larger shell. They are also less inflated with a mean T/L 0.23 (range 0.04) compared to 0.28 in the large specimen. The hinge plate is thinner, there is no interior shell thickening, with the trace of the pallial blood vessel barely visible and the shell is almost translucent.

Distribution Gulf of Oman, Pemba Channel, East Africa.

Comparison with other species *M. omanensis* differs in shell outline from the other Indian Ocean species *M. arabicus* and *M. yemenensis* (see discussion below) and is similar to the large individuals of the western Atlantic species *M. appendiculatus* (Locard 1898) and to the fossil species *M. rostratus* (Pecchioli, 1864). Compared to *M. rostratus* (Fig. 7i–j) *M. omanensis* is less thick-shelled, and the hinge plate is narrower and thinner and the anterior ventral margin does not have the sinuosity of *M. rostratus*. *M. appendiculatus* has a more extended anterior margin, with a deeper, indented anterior dorsal area Fig. 7 a–d).

*Megaxinus arabicus* n. sp. Figs 5g-h

Holotype 1v, H 26.0 mm, L 38.5 mm, T 0.74 mm, off Ras Madrakah, Oman, NMW.Z. 1995.009.1.

Type locality Arabian Sea, 19°49.43′N, 58°23.77′ E, 58 m. Discovery Expedition 1994, station reference number 211:12689/1.

Other material 4lv + 1rv, Gulf of Aden, Meteor station M31/3 105/1 12°27.6′N, 44°25.3′E, 71 m. (Institüt für Palaeontologie, University of Würtzburg).

Description Shell small, height 26.0 mm, subovate in outline with the anterior margin extended and subacute in outline, H/L 0.67. Umbones prominent, curving over the anterior dorsal area. Anterior dorsal area shallow and concave, with fine ridges, but without a distinct lunule. Escutcheon narrow and indistinct. Exterior sculpture of irregular concentric ridges with occasional distinct growth lines. Shell with remnants of a thick, yellowish-brown periostracum. Hinge plate edentulous with a few shallow folds on the posterior margin. Ligament external, narrow, slightly sunken. Inner shell margin smooth, and the inner surface of the shell chalky and pitted and with fine impressions, presumably of pallial muscles, radiating from the ventral margin. Anterior adductor muscle scar elongate and detached from the pallial line for most of its length. Posterior adductor scar ovate. Pedal muscle scars lie on ventral edge of both posterior and anterior adductor muscle scars. Pallial line continuous. Impression of the pallial blood vessel scar is deep, and runs diagonally from the posterior shell margin towards the anteroventral margin of the shell. Shell grey-white, slightly glossy.

Habitat 58-71 m.

Distribution Southern Oman and Gulf of Aden.

Comparison with other species It is not very similar to the other Indian Ocean species, *M. omanensis* (Fig. 5a–f), which has a less extended anterior margin (*M. arabicus* H/L 0.67; *M. omanensis* 1.13), a more quadrate outline and a convex antero-dorsal area. *Megaxinus arabicus* is similar in shape to both the fossil *M. transversus* and living *M. appendiculatus* from the Atlantic (Figs 7a–d, g–h), but differs in the shape of the antero-dorsal area.

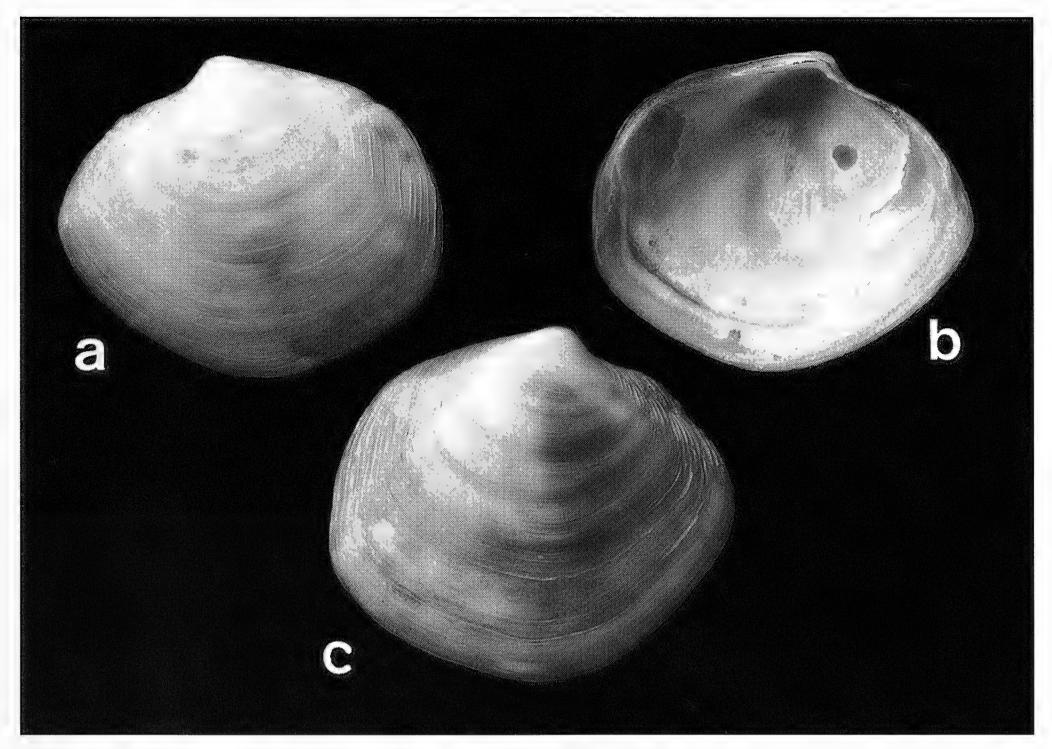
## Megaxinus yemenensis n. sp. Fig. 6

*Holotype* paired valves H  $\neq$  19.1 mm, L  $\neq$  16.6 mm. T (single valve)  $\neq$  3.8mm, SMF 311417.

*Paratypes* 1rv, H ≠ 19.5 mm, L ≠ 21.7 mm, T ≠ 4.6mm; single right valve H ≠ 10.2 mm, L ≠ 11.3 mm, T ≠ 2.5 mm, Meteor Station M31/3 105/3. 4.3.1995, SMF 311418/2.

Type locality Gulf of Aden, 12°22.8′N, 44°31.5′E. Depth 321 m.

Description Shell thin, subovate  $(H/L \neq 0.87)$  with an extended, rounded subacute, anterior margin. Posterior margin subquadrate. Umbones small. Antero-dorsal area convex, with small poorly defined, lanceolate lunule. Escutcheon narrow and indistinct. Exterior sculpture of fine concentric growth increments some of which are raised into thin lamellae. Posterior and anterior dorsal areas with more prominent, closely-spaced, thin, low lamellae; those on the posterior area lie dorsal to a line joining the ventral tip of the posterior adductor scar with the tip of the umbone. Interior of shell with thin, edentulous, hinge plate. Ligament external, narrow, slightly sunken. Inner shell margin smooth. Anterior adductor muscle scar elongate and detached from the pallial line for



**Fig. 6** *Megazinus yemenensis* new species. **a–b** Holotype SMF 311417. Exterior and interior of left valve. Height = 16.6 mm. **c** Paratype SMF311418/2. Exterior of right valve. Height = 19.5 mm.

most of its length. Posterior adductor scar oval to tear-drop shaped. Pallial line continuous. Pallial blood vessel scar faint. Shell creamy-white, dull, with thin, cream-coloured periostracum. Inside of shell, chalky-white to glossy. Paratype has large green/brown conchiolin patch between hinge and anterior adductor scar.

Habitat Known only from type locality.

Comparison with other species Megazinus yemenensis differs from M. arabicus in having less prominent umbones, a convex antero-dorsal area, concentric lamellae on the antero-and postero-dorsal areas, a more extended ventral margin and a narrower hinge plate. It is more anteriorly elongated than M. omanensis, which also lacks the ventral extension of the shell margin. The new species is most similar to the eastern Atlantic species M. appendiculatus (Locard, 1898) which has a more extended anterior margin to the shell and a more inflated antero-dorsal area which is more deeply indented below the umbones.

#### ATLANTIC AND MEDITERRANEAN SPECIES OF MEGAXINUS

Megaxinus appendiculatus (Locard, 1898) Figs 7a–d

Lucina appendiculata Locard, 1898: 279–280 pl.13 Figs 5–12 (Fig. 7 probably M. unguiculinus)

Cryptodon murchlandi Sowerby, 1907: 303, pl. 25 Fig.13. BMNH reg. no. 1907.8.28.23;

paratype, NMW.1955.158.01014.

Type locality not specified.

This species occurs in the western Atlantic, Canary Islands, Cape Verde Islands, and the African Coast to southern Angola and is probably absent from the Mediterranean. The shell is rounded to subovate, anteriorly extended with a subacute anterior margin (H/L 0.94). In larger specimens the shell is slightly higher than long, compared to the more anteriorly extended shells of the juvenile (Figs 7c–d). Posterior margin quadrate. Lunule small, heart shaped with a short, slightly convex anterior dorsal area. The hinge is edentulous, with a few irregular folds on the ventral margin. Anterior muscle scar very elongate and detached from the pallial line for at least four fifths of its length. In larger specimens, for example the holotype of *Cryptodon murchlandi*, the inner shell surface is pustulose with impressions of radial pallial muscles around the ventral margin. Shell surface smooth except for concentric growth increments. The periostracum of the holotype of *C. murchlandi* is thick and yellowish.

#### *Megaxinus unguiculinus* Pallary, 1904: 247 Figs 7e–f

Type locality: Gulf of Gabès, Tunisia.

This is the common Mediterranean species which is frequently confused with the fossil species *M. transversus*. We have examined a sample of around 25 shells from the Gulf of Gabès, Tunisia (MNHN) and preserved specimens from Greece (BMNH). The shell is small and thin, subovate to quadrate (H/L 0.99), with an extended anterior margin. The umbones are prominent, and curve over a deeply concave, heart-shaped lunule. The exterior shell surface has irregular growth lines. In preserved specimens from Greece, the periostracum consists of narrow fringes around the ventral margin.

The larval shell (Fig. 3d) consists of a large, "D" shaped, rounded prodissoconch I, 270  $\mu m$  in length. The narrow outer rim may represent a short planktotrophic prodissoconch 2 stage. The form of the larval shell indicates extended lecithotrophic development.

FOSSIL SPECIES OF MEGAXINUS

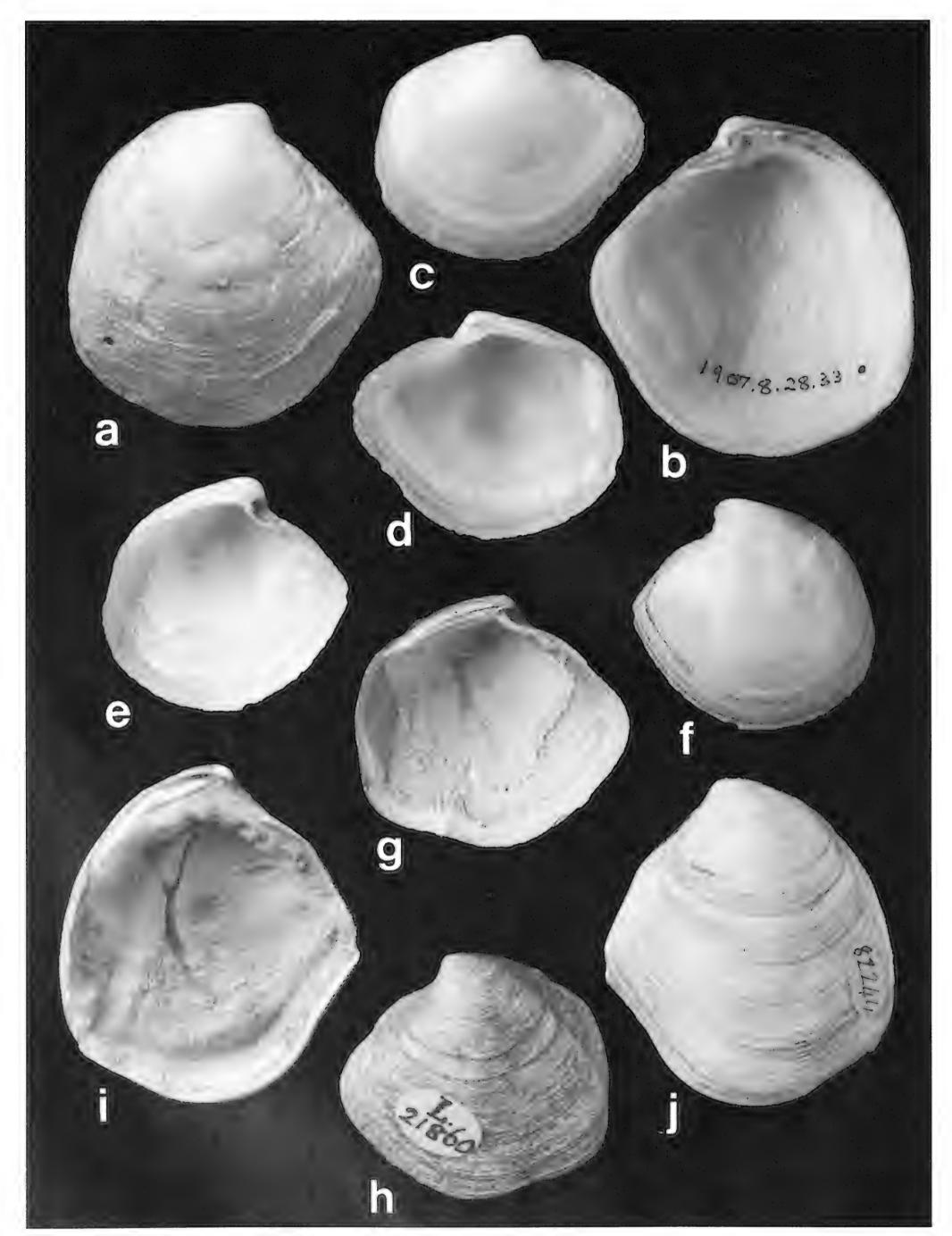
We have not attempted an exhaustive catalogue of the fossil species of *Megaxinus* (for example, the many varietal names introduced by Sacco, 1901) but briefly review below those which have some relevance to the Recent fauna. Although Sacco 1901 illustrates several species of *Megaxinus* from the Miocene and Pliocene of Italy, it is by no means certain that all these, for example *M. bellardianus* (Mayer) and *M. tenuilamellatus* (Michelotti), can be retained within the present concept of the genus.

#### Megazinus ellipticus (Borson, 1825)

Lucina ellipticus Borson 1825: 140, pl. 19, Fig. 5.

Type locality Piocene, Piedmont, Italy.

Borson's figure shows a thick-shelled, edentulous shell with a deeply impressed pallial blood vessel scar very similar in outline to *M. rostratus*. The illustration is, however, very poor and without seeing type material it is difficult to be sure that it is the same as *M. rostratus* or a similar species as suggested by Sacco (1901) and Chavan (1938). Recorded as common in the Pliocene of Italy (Sacco 1901).



**Figs 7a–d** *Megaxinus appendiculatus* (Locard, 1898) **a–b** (Holotype of *Cryptodon murchlandi* Sowerby, 1907). BMNH 1907.8.28.33, Cape Verde Islands. Exterior and interior of right valve. Height = 41.0 mm. **c–d** BMNH 1958.4.11.20. Dredged Dakar, Senegal. Exterior and interior of juvenile. Height = 18.6mm.

#### Megaxinus rostratus (Pecchioli, 1864) Figs 7i–j

Lucina rostrata Pecchioli 1864: 31, pl. 5 Figs 44-45.

Type locality Pliocene, Orciano, Italy.

This is a well illustrated species which was mentioned along with *M. transversus* in the original description of *Megazinus* by Brugnone (1880). Distinctive features are the very thick, high shell with the sinuous ventral margin and in the shell interior the deeply impressed groove marking the position of the pallial blood vessel. It may be a junior synonym of *M. ellipticus*.

*Megaxinus transversus* (Bronn, 1831) Figs 7g–h

Lucina transversa Bronn, 1831: 95.

Type locality Nizza, Italy.

This species was not illustrated by Bronn, but was likely first figured by Philippi (1836, pl. 4 Fig. 2). The shell is longer than high, subovate, a somewhat extended anterior area, a posterior sulcus, a slightly convex antero-dorsal area and a shallow, heart-shaped lunule. *M. transversus* is widespread in the Neogene of Europe (Sacco 1901, Glibert & van de Poel 1967). It has also been widely reported living in the Mediterranean but, as indicated by van Aartsen and Carrozza (1992), it has been confused with *M. unguiculinus* and it is extremely doubtful whether it is still extant. Sacco (1901) suggested that *M. transversus* are possibly thin-shelled, immature forms of *M. ellipticus/M. rostratus*. Certainly, gradational forms can be seen between typical *transversus* shapes and the thick-shelled *ellipticus/rostratus* forms. Considering the shape changes with age that we have observed in both *Rastafaria* and *Megaxinus*, as well as in other lucinids, (Taylor & Glover in press) we agree with this suggestion.

#### **DISCUSSION**

The lack of material in Australian and other museums originally led us to think that *Rastafaria* might be endemic to the Abrolhos Islands of Western Australia. The discovery of a second species, *R. calypso*, from three localities, the western Indian Ocean, Arabian Gulf and northern Red Sea, confirms a much wider distribution although it is surprising that these animals have not been described before.

Although no anatomical studies have been made of any species of *Megaxinus*, the similarity of shell characters suggests a close relationship to *Rastafaria*. Nevertheless, no

**Figs e–f** *Megazinus unguiculinus* Pallary, 1904. MNHN, Djerba, Tunisia. Interior and exterior of left valve. Height = 14.5mm.

**Figs g–h** *Megazinus transversus* (Bronn, 1831). BMNH Palaeontology Department registration number L. 21860. Pliocene, Edeghem, Belgium. Interior and exterior of left valve. Height = 22.2 mm.

**Figs i–j** *Megazinus rostratus* (Pecchioli, 1864). BMNH Palaeontology Department registration number 82244. Pliocene, Orciano, Italy. Exterior of left valve and interior of right valve. Height = 37.5 mm.

shells with *Rastafaria*-like shapes are seen amongst the *Megaxinus* species of the Neogene of southern Europe (Sacco 1901). In this paper we record for the first time the presence of Megazinus species in the Indian Ocean which, together with the occurrence of the other extant species in the central eastern Atlantic and Mediterranean, indicates a Tethyan origin for the zoogeographic distribution. The Indian Ocean species would have been isolated by the closure of the connection of the Indian Ocean to the Mediterranean in the middle Miocene (Steininger and Rögl 1985). The drying of the Mediterranean Basin in the late Miocene eliminated the marine fauna with subsequent recolonisation in the early Pliocene from the eastern Atlantic (Marasti & Raffi 1980). The early Pliocene Mediterranean was a warm, subtropical environment which is reflected in the diverse molluscan fauna and includes several Megaxinus species, such as M. ellipticus and M. transversus (Sacco 1901; Marasti & Raffi, 1980; Raffi, Stanley and Marasti 1985). Heavy extinctions of the Mediterranean molluscan fauna, including the latter two species, occurred during the late Pliocene and early Pleistocene in response to global cooling (Raffi et al. 1985) leaving a modern fauna of rather eurythermal species. Some of these Pliocene taxa survive to the present day off West Africa. Megazinus unguiculinus, the sole surviving Megazinus species of the Mediterranean, is most similar to the fossil M. transversus. As noted above, there has been much confusion between M. transversus and M. unguiculinus but the latter undoubtedly also has a fossil record, albeit unrecognised. Certainly, judging from illustrations alone Megazinus transversus var. rotundula Sacco (Sacco 1901 plate 29, Fig. 19–21) would seem to be M. unguiculinus. The large, thick-shelled forms such as M. ellipticus and M. rostratus which were common in the Pliocene of Italy (Sacco 1901) are now extinct in the Mediterranean, but similarly thick shells are seen in the eastern Atlantic M. appendiculatus and the Indian Ocean M. omanensis.

A systematic revision of the Neogene fossils of southern Europe is needed in order to establish the relationships and detailed biogeographic history of *Megaxinus* and also to establish the possible origin of *Rastafaria*.

#### **ACKNOWLEDGEMENTS**

We are grateful to Gary Rosenberg (ANSP), Philippe Bouchet (MNHN) and Ian Loch (AM) for the loan of material and to Rudo von Cosel (MNHN) for access to unpublished information on Atlantic species. Graham Oliver (NMW) made available the shell from off Oman and he also arranged for us to work on the material from the Red Sea collected by Martin Zuschin, University of Vienna, and from the Gulf of Aden kindly made available by Bettina v. Ruetzen, University of Würtzburg. We thank Harry Taylor and Phillip Hurst for macrophotography.

#### **REFERENCES**

AARTSEN J.J. VAN & CARROZZA F. 1992 European marine Mollusca: notes on less well-known species. XIII. *Megaxinus unguiculinus*. *La Conchiglia* **13(263)**: 18–20.

Borson S. 1820 Saggio di orittografia piemontese. Memorie della Reale Accademia delle Scienze di Torino 25: 180–229.

Bretsky S.S. 1976 Evolution and classification of the Lucinidae (Mollusca; Bivalvia).

- Palaeontographica Americana 8(50): 219-337.
- Bronn H.G. 1831 Italiens Tertiar-gebilde und deren organische Einschlüsse. Heidelburg 176pp.
- Brugnone G. 1880 Le conchiglie plioceniche selle vicinanze di Caltanisetta *Bolletino Società Malacologia Italiana*, **6**: 85–158.
- Chavan A. 1938 Essai critique de classification des lucines Journal de Conchyliologie 82: 215-243.
- Chavan A. 1969 Superfamily Lucinacea Fleming, 1828. In: Moore, R.C. ed. *Treatise on Invertebrate Paleontology, Part N, Mollusca 6, Bivalvia*, vol. 2. N491–N518. Geological Society of America and University of Kansas, Boulder, Colorado.
- COSEL VON R. & BOUCHET P. in prep. A deep water lucinid radiation from South-East Asian Seas.
- FISHER C.R. 1990 Chemoautotrophic and methanotrophic symbioses in marine invertebrates. *Reviews in Aquatic Sciences* **2**: 399–436.
- GLIBERT M. & POEL L. VAN DE 1967 Les Bivalvia fossiles du Cénozoique étranger des collections de l'Institut Royal des Sciences Naturelles de Belgique. V. Oligodontina. 1er partie: Lucinacea, Cyamiacea, Leptonacea, Dreissenacea, Tellinacea. Mémoires de l'Institut Royal des Sciences Naturelles de Belgique 83: 1–160.
- HICKMAN C.S. 1994 The genus *Parvilucina* in the Eastern Pacific: making evolutionary sense of a chemosymbiotic species complex *Veliger* 37: 43–61.
- KAUFFMAN E.G., ARTHUR M.A., HOWE B. & SCHOLLE P.A. 1996 Widespread venting of methane-rich fluids in Late Cretaceous (Campanian) submarine springs (Tepee Buttes), Western Interior seaway, U.S.A *Geology* **24**: 799–802.
- Lamy E. 1920 Révision des Lucinacea vivants du Museum Journal de Conchyliologie 65: 71-122.
- LE PENNEC M., BENINGER P.G. & HERRY A. 1995 Feeding and digestive adaptations of bivalve molluscs to sulphide-rich habitats *Comparative Biochemistry and Physiology* **111A**: 183–189.
- Locard A. 1898 Mollusques Testacées *Expeditions scientifique du Travailleur et du Talisman pendant les années 1880, 1881,1882, 1883* **2**: 515 pp. 18 pl.
- Marasti R. & Raffi S. 1980 Extinction of polysyringian bivalves in the Mediterranean Pliocene. In: Volume dediacato a Sergio Venzo, Istituta di Geologia, Universita degli Studi di Parma, Grafiche STEP, Parma pp. 107–115.
- Pallary P. 1904 Addition à la faune Malacologique de la Golfe de Gabès. *Journal de Conchyliologie* **52**: 212–248.
- Pecchioli V. 1864 Descrizione di alcuni nuovi fossili delle argille subappenine toscane. Atti della Società Italiana di scienze naturali, Milano 1–32.
- PHILIPI R.A. 1936 Enumeratio Molluscorum Sciciliae. Berolini 267 pp. pl. 1–12.
- POPPE G.T. & GOTO Y. 1993 European Seashells II (Scaphopoda, Bivalvia, Cephalopoda) Verlag Christa Hemmen, Wiesbaden 221 pp.
- RAFFI S., STANLEY S.M. & MARASTI R. 1985 Biogeographic patterns and Plio-Pleistocene extinction of Bivalvia in the Mediterranean and southern North Sea *Paleobiology* **11**: 368–388.
- REID R.G.B. 1990 Evolutionary implications of sulphide-oxidising symbioses in bivalves pp. 127–140 *In*: B. Morton (ed.) *The Bivalvia-Proceedings of a Memorial Symposium in Honour of Sir Charles Maurice Yonge, Edinburgh, 1986* Hong Kong University Press, Hong Kong.
- SACCO F. 1901 I Molluschi dei terreni terziari del Piemonte e della Liguria. Torino, C. Clausen 29: 3–216.
- SMITH E.A. 1906 Natural history notes from R.I.M.S. 'Investigator' Series 3, No 10. On Mollusca from the Bay of Bengal and the Arabian Sea *Annals and Magazine of Natural History* series 7 **18**: 245–264.
- Sowerby G.B. 1907 Descriptions of new marine Mollusca from New Caledonia, etc. *Proceedings of the Malacological Society of London* 7: 299–303.
- STEININGER F.F. & RÖGL F. 1985 Paleogeography and palinspastic reconstruction of the Neogene of the Mediterranean and Parathethys. In: *The geological evolution of the eastern Mediterranean* (Dixon J.E. & Robertson A.H.F. eds.),. Special Publication of the Geological Society of London 17 Blackwell Scientific Publications, Oxford pp 659–668.
- TAYLOR J.D. & GLOVER E.A. 1997 A chemosymbiotic lucinid bivalve (Bivalvia: Lucinoidea) with periostracal pipes: functional morphology and description of a new genus and species. In: Wells

#### 18 E.A. GLOVER & J.D. TAYLOR

- F.E. (ed.) *The Marine Flora and Fauna of the Houtman Abrolhos Islands, Western Australia*. Western Australian Museum, Perth pp 335–361.
- TAYLOR J.D. & GLOVER E.A. in press. The lucinid bivalve genus *Cardiolucina*: systematics, anatomy and relationships (Mollusca: Bivalvia: Lucinidae) *Bulletin of the Natural History Museum, London (Zoology)*.
- TAVIANI M. 1994 The "calcari a Lucina" macrofauna reconsidered: deep-sea faunal oases from Miocene-age cold vents in the Romagna Apennine, Italy *Geo-Marine Letters* **14**: 185–191.
- ZENETOS A. 1996 The marine Bivalvia (Mollusca) of Greece. Fauna Graeciae Athens 7: 1–319.

# THE TERRESTRIAL MOLLUSCAN FAUNA OF SOME WOODLANDS IN NORTH EAST YORKSHIRE ENGLAND: A FRAMEWORK FOR QUALITY SCORING AND ASSOCIATION WITH OLD WOODLAND FLORA

#### A.A. Wardhaugh<sup>1</sup>

Abstract The terrestrial molluscan assemblages of 17 deciduous woodlands in north-east England are considered. Several of the sites contain nationally scarce species. To assess the relative value of the woods with respect to their molluscan fauna, a quality scoring system is presented, the assemblages are analysed and the species which characterise the best quality sites are discussed. These species include Vertigo substriata, Leiostyla anglica, Spermodea lamellata, Limax cinereoniger and Zenobiella subrufescens. The occurrence of these species is correlated with the presence of certain woodland flora, a relationship which could be used on a regional basis to predict the likely quality of molluscan assemblages in other woodlands. Some of the woodlands investigated are thought to be ancient and the extent to which data on molluscs concur with this view is considered.

Key words Mollusca, flora, woodlands, quality scoring.

#### **INTRODUCTION**

A recent publication (Wardhaugh 1996) described the terrestrial molluscan fauna of 17 deciduous woodlands in the north-east of England. Several of the woodlands were found to be species rich (mean number of species per site, 29.06 ± 1.49; range 19 to 39) and to contain nationally scarce Mollusca. None of the species present are classified as nationally endangered, vulnerable or rare (Bratton 1991) but two (Ashfordia granulata and Leiostyla anglica) are of significance because the UK has a very large proportion of their world populations (Wynne 1993). In total, 51 species were recorded, this being approximately 45% of the British fauna. In recent years the quantification of site assessment has been seen as increasingly important since it facilitates interpretation of species lists, site comparison and decision-making in conservation (Ratcliffe 1986). With respect to their molluscan fauna, the species richness of several of the sites surveyed indicates that they may be of considerable conservation value and the present paper contains details of a quality scoring system developed as an attempt to assess their relative value. Similar systems have been devised for other invertebrate groups, for example those of Foster (1987) and Eyre & Rushton (1989) for freshwater and terrestrial Coleoptera and of Archer (1993; 1995) for aculeate Hymenoptera.

It was considered that further investigation of the woodlands might provide useful information on the extent to which the occurrence of both individual species and assemblages of mollusc might be correlated with the presence of selected species of the woodland flora. If any such relations exist, then they could serve as useful predictors of site quality as regards molluscs, at least on a regional basis. Although there are several published works dealing with the molluscan assemblages of woodlands in the British Isles (Cameron and Redfern 1972; Berry 1973; Cameron 1973, 1978; Paul 1975a, 1978a, 1978b; Bishop 1976, 1977; Tattersfield 1990), there does not seem to have been any systematic investigation of their association with woodland flora.

Nine of the seventeen woodlands investigated are thought to be ancient, i.e. in contin-

<sup>&</sup>lt;sup>1</sup> 13 Captain Cook's Crescent, Marton, Middlesbrough, TS7 8NN.

uous existence since at least 1600 AD (Carter 1987a, 1987b; Cooke 1987). All of the flora considered in the present work are thought to be indicative of ancient status (e.g. Peterken 1981) and so too are some of the Mollusca (Boycott 1934; Kerney and Stubbs 1980). Hence a further aspect that can be considered is the extent to which the data suggesting ancient status concur.

#### **METHODS**

Fifteen woodlands in north-east Yorkshire (Watsonian vice-county 62) and two nearby in Durham (vice-county 66) were surveyed (Wardhaugh 1996). Mollusc recording combined searching on site and hand sorting of leaf litter and ground layer vegetation samples. Each woodland was visited several times and at different times of year. Recording was considered complete when no new species were found after a minimum of thirty minutes additional searching.

For quality scoring, a scheme was devised in which each species of mollusc recorded was allocated a score of 1, 2, 4, 8 or 16 (Table 1). This was used to generate four indices of quality, species rarity total (SRT), species quality factor (SQF), rarity association total (RAT) and rarity quality factor (RQF) (after Eyre and Rushton 1989). The SRT is the sum of scores for all species found in a woodland. The SQF is calculated as the SRT divided by the species total for the wood. For the RAT, the scores of all species other than those with a score of one are summed. If, however, one species alone has a score higher than all others, then this is reduced to the next highest total (e.g. a series of scores 16, 8, 4, 4, 2, 2, would be adjusted to 8, 8, 4, 4, 2, 2). The aim of this is to correct for upward bias in the SRT values in situations where one rare species occurs in a wood with otherwise common ones. The total thus calculated is added to the SRT, the result being the RAT. Finally, the latter is divided by the species total for the wood to produce the RQF (which thus parallels the SQF).

Some of the decisions that had to be made in devising the quality scoring system were not easy. For example, the score which should be credited to synanthropic species (Group B) is problematic, all of the species involved being common in appropriate habitats except for Boetgerilla pallens. This slug is a fairly recent introduction to Britain (Colville, Lloyd-Evans and Norris 1974) and is comparatively scarce, although spreading rapidly. Other difficult decisions included ascribing scores to nationally common species at the edge of their geographic range, for example Oxychilus helveticus, and to wetland species found within the woodlands. Although it is inevitable that decisions of this type are subjective, it was felt that the scheme developed would prove to be more satisfactory than one of a simpler structure. For example, both those of Eyre and Rushton (1989) for Coleoptera and of Archer (1993, 1995) for aculeate Hymenoptera group all species into a series of categories, on a geometric scale of increasing scarcity, with reference to appropriate regional data banks. Thus all regionally scarce species receive a high score irrespective of other factors such as status at a national level or whether they are native or introduced. In the present study species such as B. pallens would be credited with an unacceptably high score in a scheme of this type. When considering an assemblage of comparatively few species (51 in this investigation) this type of problem could introduce significant bias. In attempting to avoid this, it has been necessary to classify species into some 10 groups and subgroups, a situation which is somewhat complex and which does depend on a knowledge of local distribution patterns. If the scheme were to be used in a wider context, simplification would be highly desirable. Finally, in any scheme such as this, which is based upon simple recording of presence or apparent absence of species, no account is taken of population size or

#### TABLE 1

#### Quality scoring scheme developed for woodland terrestrial molluscs

**GROUP A** 

Species with no particular woodland association i.e. found in both woodland and non-woodland habitats.

Very common. Located in at least 15 of the 17 woods in the present study (= <88%) A1

SCORE = 1

Carychium tridentatum Arion circumscriptus Aegopinella pura Cochlicopa lubrica Arion distinctus Aegopinella nitidula Oxychilus cellarius Lauria cylindracea Arion intermedius Discus rotundatus Oxychilus alliarius Vitrina pellucida Arion ater Vitrea crystallina Deroceras reticulatum

Euconulus fulvus

A2 Common. Located in 9 to 14 of the 17 woods (= 53% to 82%)

SCORE = 2

Arion subfuscus Nesovitrea hammonis Trichia hispida Arion fasciatus Limax maximus Cepaea nemoralis

> Occasional. Located in 4 to 8 of the woods (= 24% to 47%) **A**3

> > SCORE = 4

Cepaea hortensis Arion silvaticus Vitrea contracta

> **A4** Locally uncommon. Located in 3 or less woods (= <18%)

> > SCORE = 8

Oxychilus helveticus

A5 Locally common in habitats other than woodland.

SCORE = 2

Cochlicopa lubricella

**GROUP B** Synanthropic species. Indicative of site disturbance.

SCORE = 1

Tandonïa budapestensis Helix aspersa Deroceras caruanae

Trichia striolata

GROUP C Wetland species. SCORE = 4

> Carychium minimum Oxyloma pfeifferi Deroceras laeve

Euconulus alderi

Boetgerilla pallens

GROUP D Woodland species

> D1 Common. At least some association with woodland in the study area but sometimes occur in

other habitats.

SCORE = 4.

Clausilia bidentata Columella edentula Punctum pygmaeum Acanthinula aculeata Limax marginatus Arianta arbustorum

> D2Locally scarce. Virtually confined to woodland in the study area.

Azeca goodalli Cochlodina laminata Ashfordia granulata

Columella aspera

D3Nationally scarce and declining. Thought to be indicative of ancient woodland (Kerney and

Stubbs 1980) SCORE = 16

Spermodea lamellata Vertigo substriata Zenobiella subrufescens

Leiostyla anglica Limax cinereoniger density. Future schemes might aim to include these aspects in site quality assessment.

In order to determine whether there was any correlation between the presence of certain mollusc species, or assemblages of high quality, and elements of the woodland flora, the occurrence of six species of flowering plant was noted. These were Anemone nemorosa (wood anemone), Öxalis acetosella (wood-sorrel), Lysimachia nemorum (yellow pimpernel), Galium odoratum (woodruff), Luzula sylvatica (greater woodrush) and Carex pendula (pendulous sedge). These species are all conspicuous and easily identified, this being one of the reasons for their inclusion in this work. Thus it was comparatively easy to establish either their presence or absence from a wood, the latter with a high level of confidence. The principal basis for selection of these species was a list of plants produced by Peterken (1981), stated to have a strong affinity for ancient woods, showing little or no ability to colonise secondary woodland and rarely found in other habitats. This list, which contains 34 species, is based on work carried out chiefly in Lincolnshire and was used in the present study because comparable botanical data for north-east Yorkshire appears to be lacking. This was considered to be unimportant partly because the list probably applies well to the latter region and also because, as outlined above, the primary aim of the work was to investigate correlation between the occurrence of molluscs and herbaceous flowering plants rather than assessment of woodland age per se. Many of the plants listed by Peterken were not adopted for the current work either because the study area falls outside their geographic range (e.g. Sorbus torminalis and Paris quadrifolia) or because they are so uncommon in the area that data on their distribution would be of very little value in the present context e.g. Convallaria majalis and Platanthera chlorantha (Sykes 1993; Lawrence 1994). Other species were not used because they are both scarce and somewhat inconspicuous and it was felt that it would be difficult to establish their absence from a site with confidence e.g. Lathraea squamaria.

The value of many flowering plants as indicators of ancient status of woodlands has been disputed by Spencer (1990) who rejects for example *Viola* spp., *Primula vulgaris* and *Euphorbia amygdaloides* on the grounds that they can occur in coppices of quite recent origin. Spencer lists five species whose sole occurrence he considers to be a reliable indication of ancient status. Of these, only *Anemone nemorosa* occurs with any frequency in the study area, the other four being very scarce (*Tilia cordata* and *C. majalis*) or probably absent altogether (*S. torminalis* and *P. quadrifolia*). Hence perhaps particular emphasis might be placed on the distribution of this species and any molluscan assemblages occurring with it in the present study.

#### **RESULTS**

In total 51 species of terrestrial mollusc were recorded during the study (Table 1). A full record of the species occurring in each wood is provided elsewhere, together with details of the area, altitude, aspect, geology, moisture level and dominant tree species (Wardhaugh 1996). Table 2 indicates the total number of mollusc species recorded in each wood and the various quality scores. Of the latter, none significantly alters the rank order of sites compared with that based on species total. However, the SRT is useful in that it takes into account both species richness and rarity and serves well in accentuating differences between woods with respect to quality. Thus the seven most species rich sites have scores ranging from 73 to 141 for a range of 32 to 39 species but the rank order remains unchanged. The two highest ranking sites (Wilton Wood and Saltburn Gill; 39 species each) differ in SRT by 10 points, a contributory factor being the presence of four nationally scarce species in the former compared with two in the latter (Table 4). Three woodlands were found to have 32 species but their SRT scores were 101 (Avens Wood),

82 (Dunsdale wood) and 73 (Brewsdale), reflecting differences in species quality.

In general, SQF scores follow a similar pattern to the SRT values and hence provide little additional insight. Interpretation of the former index requires some care because extreme cases are conceivable where the calculated value could be misleading. For example a site containing just three species, all nationally scarce, would have an SQF value of 16. Both Eyre and Rushton (1989) and Archer (1993, 1995) indicate that in their schemes, an SQF score of more than 2 is indicative of a good quality site ("good quality" not being defined by the authors however). In Archer (1993,1995), for aculeate Hymenoptera, scores of 1, 2, 4, 8, 16 and 32 are employed, with 1, 2 and 4 representing common, frequent and occasional species respectively. Thus an SQF score of greater than

TABLE 2
Species totals and quality scores for the woodlands surveyed
All woodlands are in 100km square 45 (=NZ)

			•		
Woodland (Grid ref.)	SPECIES TOTAL	SRT species rarity total	SQF species quality factor	RAT rarity association total	RQF rarity quality factor
Wilton (593197)	39	141	3.62	265	6.79
Saltburn Gill (675208)	39	131	3.36	245	6.28
Mulgrave (845118)	37	120	3.24	222	6.00
Kilton (707180)	34	115	3.38	213	6.26
Avens (703139)	32	101	3.16	187	5.84
Dunsdale (601190)	32	82	2.56	138	4.31
Brewsdale (465106)	32	73	2.28	125	3.91
Woodcock (550170)	30	63	2.10	95	3.17
Bassleton (445115)	29	52	1.79	80	2.76
Bonnygrove (519142)	27	48	1.78	74	2.74
Burn (386154)	26	43	1.65	69	2.65
Marton W. Beck (517145)	26	36	1.38	52	2.00
Gt. W. Plantation (546166)	25	38	1.52	58	2.32
Lazenby Bank (573190)	25	54	2.16	80	3.20
Newton (575124)	22	46	2.09	64	2.91
Eaglescliffe (426149)	20	24	1.20	32	1.60
Cliff Ridge (574115)	19	30	1.58	46	2.42
Mean ±S.E.	29.06 ±1.49	70.4 ±9.13	2.29 ±0.19	120.3 ±18.6	3.83 ±0.42

#### 24 A.A. WARDHAUGH

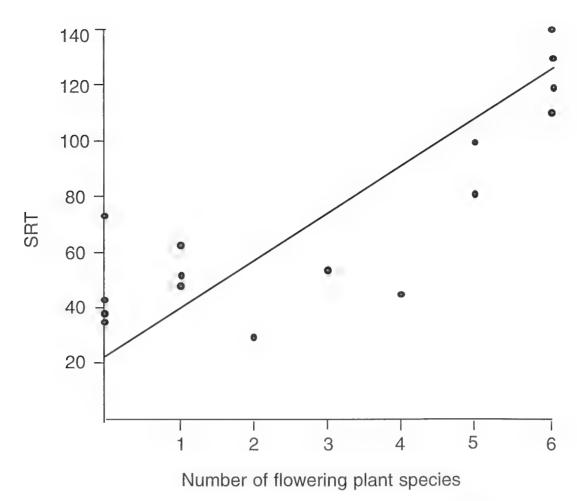
two would indicate no more than the average species at the site concerned was less than frequent, at least to some extent. It is often the case (e.g. Boycott 1934), and demonstrated clearly in the present study, that among woodland Mollusca common species are not replaced by scarce ones in areas of high quality, rather the latter occur in addition to the former. This pattern in molluscan assemblages will have a considerable impact upon SQF values. In the present context, and perhaps in quality scoring schemes for other taxa, it may be of more value to compare the SQF value for one site with the mean for all sites under consideration. Hence, Table 2 includes means for all quality scores. In the present context a good quality site might be defined as one with an above average SQF score (2.29±0.19, range 1.20 to 3.62). In the present work, rankings for RAT and RQF scores are very similar to those for SRT and SQF respectively and do not reveal anything further of significance. Eyre and Rushton (1989) found that for a series of ground beetle sites, calculation of the RQF resulted in some reordering of the highest quality sites but for water beetle sites the order remained unchanged. A relatively high RQF compared with the SQF would indicate a site with a high proportion of scarce species, a situation which appears to be uncommon among woodland molluscs as indicated above.

Table 3 indicates the occurrence of the six species of flora recorded and the extent to which each is associated with the putative ancient woodlands (Carter 1987a, 1987b;

TABLE 3 Flowering plants recorded in the woodlands surveyed

Woodland	Anemone nemorosa	Oxalis acetosella	Lysimachia nemorum	Galium odoratum	Luzula sylvatica	Carex pendula
+ Wilton	•	•	•	•	•	•
+ Saltburn Gill	•	•	•	•	•	•
+ Mulgrave	•	•	•	•	•	•
+ Kilton	•	•	•	•	•	•
+ Avens	•	•	•	•	•	-
+ Dunsdale	•	•	-	•	•	•
+ Newton	•	•	•	-	•	-
Lazenby Bank	•	•	-	~	-	•
+ Cliff Ridge	•	•	-	-	-	-
+ Bassleton	•	-	-	-	-	-
Woodcock	-	•	-	-	-	-
Bonnygrove	-	-	•	-	-	_
Burn	-	-	-	-	-	<b>↔</b>
Brewsdale	-	-	-	~	-	-
Gt. W. Plantation	-	-	-	-	-	-
Marton W. Beck	-	-	-	-	-	-
Eaglescliffe	-	-	-	-	-	_
NUMBER OF ANCIENT OODS IN WHICH PRESENT (Max. = 9)	' 9	8	6	6	7	5
UMBER OF OTHER WOODS IN WHICH PRESENT (Max. = 8)	5 1	2	. 1	0	0	1

<sup>+</sup> denotes Ancient, as listed by Carter (1987a, 1987b) and Cooke (1987), i.e. probably in existence since at least 1600AD



**Fig. 1** Relationship between SRT and number of flowering plant species recorded. For fitted regression line b = 0.057. Spearman rank-correlation coefficient = 0.809;  $\alpha < 0.01$ 

Cooke 1987). The associations between SRT, the categories of mollusc, the flora and woodland age are indicated in Table 4. This reveals a clear association between the flora and the site quality for Mollusca (Spearman rank-correlation coefficient = 0.809;  $\alpha$ < 0.01). Thus the six top ranking sites by SRT were found to be the only ones containing either five or six of the plant species recorded.

The woods with higher rankings by SRT tend to have higher totals for Dl, D2 and D3 species as would be expected. However, this is notably the case for D3 species which indicates that they are genuinely associated with the best quality woodlands. It is conceivable that the occurrence of the D3 species could be randomly spread through the ranking, without altering the relative position of the top six woods. If this were so, then the D3 species would not be associated with the best quality sites. This would in turn cast doubt on their potential value as indicator species in other woodlands in the region.

For further analysis of this aspect of the work, SRT values have been plotted against number of species of indicator flowering plant (Figure). On the basis of this, and also Table 4, the woods have been divided into two groups. One comprises the top six sites as ranked by SRT, which all contain five or six of the plant species (here on called the key woods) and the other group consists of the remaining sites. All woodland Mollusca (i.e. groups Dl, D2 and D3) are listed in Table 5, ranked by their level of association with the key woods. With the exception of *L. anglica*, all the D3 species lie towards the top of the list and the lower ranking species all belong to group Dl. Again, this suggests that the quality scoring scheme is satisfactory in general.

Of the seventeen woods investigated, nine are considered to be ancient (Carter, 1987a, 1987b; Cooke 1987), these being all the key woods together with three others (Tables 3 and 4). Of the plant species recorded, the mean number occurring in the putative ancient woods is  $4.56 \pm 0.627$ , and for the other woods  $0.63 \pm 0.375$ , the difference being highly significant (t = 5.22; P < 0.001). All six plant species have a marked tendency to be present in the ancient woods and to be absent from the remainder.

Similarly, the ancient woods have significantly better quality molluscan faunas (mean SRT 90.9  $\pm 13.42$  compared with 47.4  $\pm 5.55$  for the other sites; t = 2.86; P • / • 0.02 and 0.01). Of the five woodland mollusc species listed by Kerney and Stubbs (1980) as characteristic of old woodland, all except *L. anglica* appear to be strongly associated with the

ancient sites (Table 5).

TABLE 4
Relationship between SRT score for molluscs, numbers of species of molluscs within each woodland category, number of flowering plant species recorded and woodland age.

Woodland	SRT		ES OF MOL IN CATEGO D2		FLORA (No)
+ Wilton	141	4	0	6	6
+ Saltburn Gill	131	2	3	5	6
+ Mulgrave	120	2	3	6	6
+ Kilton	115	2	3	4	6
+ Avens	101	2	1	6	5
+ Dunsdale	82	1	1	5	5
Brewsdale	73	0	1	6	0
Woodcock	63	1	0	1	1
Lazenby Bank	54	1	0	2	3
+ Bassleton	52	0	1	3	1
Bonnygrove	48	0	0	1	1
+ Newton	46	1	0	1	4
Burn	43	0	0	0	0
Gt. W. Plantation	38	0	0	2	0
Marton W. Beck	36	0	0	2	0
+ Cliff Ridge	30	0	0	2	2
Eaglescliffe	24	0	0	0	0
MAXIMUM	-	5	4	6	6

D3, D2, D1 denote woodland mollusc categories (see Table 1 for details)

#### **DISCUSSION**

The results of this study indicate that there are associations between species richness and quality for Mollusca, the flora and also the likely age of the woods, several aspects of these relationships being worthy of further comment.

In a previous publication (Wardhaugh 1996) patterns of similarity between the woodlands with respect to their molluscan fauna were analysed by calculating Sorenson's coefficients for all possible pairs of sites and the data were used to construct a dendrogram. One of the resultant clusters of similar sites included the six key woods (together with one other, Brewsdale, which was found to be quite species rich but of lower quality; Table 2). Hence the key woods, in addition to being the richest and best quality sites, do also form a discrete group. The species which characterise them are thus worthy of further consideration (Table 5). Data from a greater number of woodlands would be desirable but nevertheless, the overall pattern is of interest. The D3 species, listed by Kerney and Stubbs (1980) as characteristic of ancient woodland, rank first (*S. lamellata*), second (*Z. subrufescens*), joint third (*V. substriata*), sixth (*L. cinereoniger*) and thirteenth (*L. anglica*). Data are few (thus *V. substriata* and *L. cinereoniger* were found at only two sites

<sup>+</sup> denotes Ancient, as listed by Carter (1987a, 1987b) and Cooke (1987), i.e. probably in existence since at least 1600AD

TABLE 5
Occurrence of woodland molluscs (i.e. category D species) in the key woodlands and others.

		NUMBER OF WOODS IN WHICH PRESENT					
	D CATEGORY	KEY  (n = 6)	OTHERS $(n = 11)$	ANCIENT $(n = 9)$	$ SECONDARY \\ (n = 8) $		
S. lamellata •	3	4	0	4	0		
Z. subrufescens •	3	3	0	3	0		
C. aspera	2	2	0	3	0		
A. goodalli	2	2	0	2	0		
V. substriata •	3	2	0	2	0		
L. cinereonige r•	3	1	0	1	0		
C. edentula	1	6	1	6	1		
C. laminata	2	4	1	5	0		
A. granulata	2	3	1	3	1		
C. bidentata	1	6	2	7	1		
A. arbustorum	1	6	3	7	2		
L. marginatus	1	5	3	6	2		
L. anglica •	3	3	3	4	2		
P. pygmaeum	1	5	4	7	2		
A. aculeata	1	4	6	5	5		

Key woodlands are the six top ranking sites listed in Table 4.

and one site respectively), hence rather than consider ranking, it is perhaps of greater significance to note that of these five species, only *L. anglica* occurred in woods other than the key ones. This is an interesting anomaly. Of the three non-key woods in which it was located, only Newton Wood is considered to be of ancient status (Carter 1987a; Cooke 1987). This site contained four of the six plant species under consideration (Table 3) but its molluscan fauna was comparatively poor in both species richness and quality, with the exception of the presence of *L. anglica* (Table 2). Hence Newton Wood occupies a somewhat intermediate position in the current analysis. Within each of the three non-key woods in which *L. anglica* was found to occur, it appeared to be restricted to single, small populations in damp areas, which have perhaps remained less disturbed than their surroundings. Alternatively, in this part of Britain, *L. anglica* may not always be confined to woods which are ancient.

Boycott (1934) considered 13 species of mollusc to have special woodland alliances, especially *L. cinereoniger* and *L. tenellus*. The latter was not located in the present survey. The remaining eleven species were *Helicigona lapicida*, *Helicodonta obvoluta*, *Ena montana*, *Macrogastra rolphii*, *Acicula fusca*, *Zonitoides excavatus*, *L. anglica*, *S. lamellata*, *Z. subrufescens*, *L. marginatus* and *C. laminata*. Of these, the first four are unknown in the study area whilst *A. fusca* and *Z. excavatus* are extremely scarce (Kerney 1976). *L. anglica*, *S. lamellata* and *Z. subrufescens* are considered above. This leaves *L. marginatus* and *C. laminata*. The former does not seem to have any particular associations with either the key or putative ancient woods. However, *C. laminata*, here ranked as a D2 species, does seem to have some association with the key woods (Table 5). Moreover, the only non-key woodland in which it was found (Bassleton Wood) is listed as possibly ancient (Cooke 1987). Lloyd-Evans (1981) stated that *C. laminata* is locally distributed in Yorkshire, preferring old deciduous woodland on base-rich soils whilst Cameron *et al.* (1980) found it to be significantly associated with hedgerows of woodland origin when

<sup>•</sup> denotes listed as characteristic of old woodlands by Kerney and Stubbs (1980)

compared with those originally planted in open fields. The latter study provides an interesting parallel with the present work; in three areas of the English Midlands, composition and richness of hedgerow snail faunas were found to be influenced by both historical and environmental factors. Hedges originating in or near woodland were

found to have richer snail faunas than those planted in open fields.

In the present study, two further species (*A. goodalli* and *C. aspera*) were restricted to the key woods and *C. edentula* was strongly associated with these sites (Table 5). Again, Cameron *et al.* (1980) found *A. goodalli* to be significantly associated with hedgerows of woodland origin, whilst both this species and *C. edentula* were found to be characteristic of ancient woodland in Cambridgeshire (Paul 1978b). However, it should be borne in mind that at a national level, the *Columella* species occur in habitats other than deciduous woods (Paul 1975b; Kerney and Cameron 1979). Similarly, Boycott (1934) described *L. cinereoniger* as, "never found except in woodlands which have every appearance of being ancient and which are generally large" whilst Norris (1974) stated that it is, "almost confined in Yorkshire to areas of old mixed woodland". However, in marked contrast, Bishop (1976) commented that in Somerset, "the idea that *L. cinereoniger* is an indicator of original forest is not true: it is common in woodland including [a] modern plantation in the Nettlecombe district". In the latter area, perhaps the presence of this species indicates continuity of woodland cover rather than the antiquity of the lineage of the trees present.

In addition to being the best quality sites for Mollusca, the key woods are characterised by the presence of five or six of the flowering plant species recorded and all are thought to be ancient (Table 4). However, three of the non-key woods are also deemed to be ancient (Newton Wood, considered above, Cliff Ridge Wood and Bassleton Wood). All show signs of past disturbance through either grazing, mineral extraction or conifer planting and the second of these is very dry (Wardhaugh 1996). However, in spite of the presence of several of the flowering plants in one of them and their possible age, all are lacking in a molluscan fauna of quality, with an almost complete absence of D3 species. These observations are few but suggest that age per se is no guarantee of a high quality molluscan fauna. In addition, it seems that a site must be undisturbed and at least fairly moist in places. These findings concur with the views of Boycott (1934) that the molluscan fauna of woodlands depends upon their age and the degree of moisture, shelter and calcium provided. Kerney (1966) stated that five species, including S. lamellata, are normally easily exterminated by disturbance of their habitats whilst Cameron and Redfern (1972) and Cameron (1973) also concluded that disturbance is detrimental to the quality of woodland molluscan assemblages.

Of the five species said to be characteristic of old woodland (Kerney and Stubbs 1980) and discussed above, all except *L. cinereoniger* have a distinct northerly or northern and western distribution but *V. substriata* and *S. lamellata* at least were more widespread in the south during the Flandrian period (Kerney 1976). A westerly component in present day distribution may indicate the need for an Atlantic climate yet mean annual rainfall in north-east Yorkshire, where these species occur, is low compared with most other parts of Britain. Here, lack of disturbance in the steep-sided, shady woodland valleys which they often inhabit, may be of considerable importance. Unlike many other woods in more southerly parts of England, regular coppicing did not take place at these sites in the past (Cooke 1987), a practice which can cause severe periodic disturbance of the ground and field layers and their consequent desiccation. The effects of coppicing on woodland molluscs seem to have been little studied and the available data are some-

what equivocal (Berry 1973; Paul 1978a; Reynolds 1993).

It is apparent that division of the woods investigated into the two categories, ancient and secondary, with the implication that only the former are of conservation interest, is too simplistic. Each woodland has a unique history, especially with respect to exploita-

tion by man, and this will have affected different taxa in different ways. Nonetheless, attempts to identify potentially ancient woodlands, largely from cartographic evidence (Carter 1987a, 1987b; Cooke 1987), are useful in that they do indicate the sites more likely to be of higher diversity. It should be stressed that these inventories were considered by their authors to be provisional, the intention being that further studies would be carried out. The extent and reliability of the evidence available for each of the woods was acknowledged to be variable, hence classification of the woods investigated in the present study, as ancient or secondary, should not be regarded as definitive. Finally, it should be noted that the inventories did not consider woods of less than 2h in area. However only one site in the present study (Eaglescliffe Wood) is below this size and is deemed to be secondary on cartographic evidence.

Consequently, although there are statistically significant associations between likely ancient status, the occurrence of the flora recorded and quality of the molluscan fauna, these limitations should be borne in mind.

It has been argued that for ecological work to be of real value, it should be predictive (Peters 1991). In the present study, association in occurrence between the flora and molluscs of the key woods (rather than those deemed to be ancient) is evident. Hence it can be predicted tentatively that other woods in the region having five or six of the flora species are likely to contain the most species rich and the best quality molluscan assemblages (approximately 32 or more species). This is especially likely if the site is at least fairly moist in part and relatively undisturbed (Wardhaugh 1996). Conversely, woods containing one or none of the flora species are likely to have a depauperate molluscan fauna (fewer than 32 species). Hence data on flora, which can be collected easily or which may already exist, may serve as a useful predictor of site quality for Mollusca.

#### **ACKNOWLEDGEMENTS**

I am grateful to Mr I.C. Lawrence for his help in providing some of the records for flora employed in this study.

#### REFERENCES

- ARCHER M.E. 1993 Recorder's fourth report on the aculeate Hymenoptera in Watsonian Yorkshire and the development of a quality scoring system *Naturalist* **118**: 13–15.
- ARCHER M.E. 1995 Aculeate wasps and bees (Hymenoptera: Aculeata) of Blaxton Common in Watsonian Yorkshire with the introduction of a new national quality scoring system *Naturalist* **120**: 21–29.
- Berry F.G. 1973 Patterns of snail distribution at Ham Street Woods National Nature Reserve, E. Kent *Journal of Conchology* London **28**: 23–36.
- BISHOP M.J. 1976 Woodland Mollusca around Nettlecombe, Somerset Field Studies 4: 457–464.
- BISHOP M.J. 1977 The Mollusca of acid woodland in West Cork and Kerry *Proceedings of the Royal Irish Academy* Section B **13**: 227–244.
- BOYCOTT A.E. 1934 The habitats of land Mollusca in Britain Journal of Ecology 22: 1–38.
- Bratton J.H. (ed.) 1991 British Red Data Books:3. Invertebrates other than Insects Joint Nature Conservation Committee, Peterborough.
- CAMERON R.A.D. 1973 Some woodland mollusc faunas from southern England *Malacologia* 14: 355–370.
- CAMERON R.A.D. 1978 Terrestrial snail faunas of the Malham area Field Studies 4: 715–728.

CAMERON R.A.D., DOWN K. & PANNETT D.J. 1980 Historical and environmental influences on hedgerow snail faunas *Biological Journal of the Linnean Society* **13**: 75–87.

Cameron R.A.D. & Redfern M. 1972 The terrestrial Mollusca of the Malham area *Field Studies* 3: 589–602.

CARTER A. 1987a North Yorkshire Inventory of Ancient Woodland Part II:Harrogate, Hambleton, Selby and York. (Provisional) English Nature, Peterborough.

CARTER A. 1987b North Yorkshire Inventory of Ancient Woodland. Part Ill: Ryedale and Scarborough (Provisional) English Nature, Peterborough.

Colville B., Lloyd-Evans L. & Norris A. 1974 Boetgerilla pallens Simroth, a new British species *Journal of Conchology* London **28**: 203–208.

COOKE R. 1987 Cleveland Inventory of Ancient Woodland. (Provisional) English Nature, Peterborough.

EYRE M.D. & RUSHTON S.P. 1989 Quantification of conservation criteria using invertebrates *Journal* of Applied Ecology **26**: 159–171.

FOSTER G.N. 1987 The use of Coleoptera records in assessing conservation value of wetlands. In The Use of Invertebrates in Site Assessment for Conservation (ed. M.L. Luff) Agricultural Environment Research Group, University of Newcastle-upon-Tyne 8–17.

Kerney M.P. 1966 Snails and man in Britain Journal of Conchology 26: 3-14.

Kerney M.P. 1976 Atlas of the non-Marine Mollusca of the British Isles. Institute of Terrestrial Ecology, Abbots Ripton, Huntingdon.

KERNEY M.P. & CAMERON R.A.D. 1979 A Field Guide to the Land Snails of Britain and North-West Europe Collins, London.

Kerney M.P. & Stubbs A. 1980 The Conservation of Snails, Slugs and Freshwater Mussels English Nature, Peterborough.

LAWRENCE I. 1994 A Guide to the Wild Flowers of Cleveland Cleveland County Council, Middlesbrough.

LLOYD-EVANS L. 1981 Y.N.U. Excursions in 1980 Naturalist 106: 118.

NORRIS A. 1974 Y.N.U. Excursions in 1974 Naturalist 99: 148.

Paul C.R.C. 1975a The ecology of Mollusca in ancient woodland. 1. The fauna of Hayley Wood, Cambridgeshire *Journal of Conchology* **28**: 301–327.

PAUL C.R.C. 1975b Columella in the British isles Journal of Conchology 28: 370–383.

Paul C.R.C. 1978a The ecology of Mollusc in ancient woodland. 2. Analysis of distribution experiments in Hayley Wood, Cambridgeshire *Journal of Conchology* **29**: 281–294.

Paul C.R.C. 1978b The ecology of Mollusca in ancient woodland. 3. Frequency of occurrence in west Cambridgeshire woods. *Journal of Conchology* **29:** 295–300.

Peterken G. 1981 Woodland Conservation and Management Chapman & Hall, London.

Peters R.H. 1991 A Critique for Ecology Cambridge University Press.

RATCLIFFE D.A. 1986 Selection of important areas for wildlife conservation in Great Britain: The Nature Conservancy Council's approach. In *Wildlife Conservation Evaluation* (ed. M.B. Usher) Chapman & Hall, London 135–159.

REYNOLDS J. 1993 Comparison of species in coppiced and unmanaged woodland at the Loder Valley Reserve, Wakehurst Place, Surrey *The Conchologists' Newsletter* 7: 210–216.

Spencer J. 1990 Indications of antiquity. Some observations on plants associated with ancient woodland *British Wildlife* 2: 90–102.

Sykes N. 1993 Wild Plants and their Habitats in the North York Moors North York Moors National Park, Helmsley.

Tattersfield P. 1990 Terrestrial molluscan faunas of some south Pennine woodlands *Journal of Conchology* **33**: 355–374.

WARDHAUGH A.A. 1996 The terrestrial molluscan fauna of some woodlands in north east Yorkshire, England *Journal of Conchology* **35**: 313–327.

WYNNE G. 1993 Biodiversity Challenge: an Agenda for Conservation in the U.K. R.S.P.B., Sandy.

## REVISION OF *ELIA* (*ACROEUXINA*) O. BOETTGER, 1877 (GASTROPODA: CLAUSILIIDAE)

#### B. Hausdorf<sup>1</sup>

Abstract The species and subspecies of Elia (Acroeuxina) O. Boettger, 1877 (Gastropoda: Clausiliidae) from NW-Turkey are revised. Three species are distinguished, two of which polytypic, with three and two subspecies, repectively. Three new subspecies are described: E. (A.) huebneri interior; E. (A.) huebneri concava; and E. (A.) retowskii levata. For every taxon the shell is described and illustrated and measurements of several sections of the genitalia are shown. The diagnostic characteristics are summarized in a table. The locality records are listed and the distributions of the taxa displayed on UTM-grid-maps.

Key words Elia, Acroeuxina, Clausiliidae, systematics, distribution, Turkey.

#### **INTRODUCTION**

So far there are only a few records of the subgenus *Elia* (*Acroeuxina*) O. Boettger, 1877 (Gastropoda: Clausiliidae), which is restricted to the Pontic region of NW-Anatolia. This is not due to the rarity of the *Acroeuxina* species, but to the inadequate malacological exploration of that region. In this paper the species and subspecies of *Elia* (*Acroeuxina*) from NW-Turkey are described and their locality records are listed.

#### MATERIAL AND METHODS

The synonymic lists include only the original descriptions and quotations including new facts. The counting of the shell whorls follows Kerney & Cameron (1979: 13). In the locality lists the localities are arranged according to Vilayets (Turkish provinces). Within the vilayets the localities are ordered alphanumerically according to the UTM-code. The material on which this study is based is kept in the collections listed under abbreviations. Most specimens were collected by the author between Bursa and Cide. Additional forms of *Acroeuxina* may live especially eastwards from Cide.

#### Abbreviations for collections

HAU Collection B. Hausdorf.

IZPAN Polska Akademia Nauk, Instytut Zoologii, Warszawa.

MEN Collection H. P. M. G. Menkhorst. NHMW Naturhistorisches Museum, Wien.

NNM Nationaal Natuurhistorisch Museum, Leiden.

SMF Senckenberg-Museum, Frankfurt a. M.

ZIM Zoologisches Institut und Zoologisches Museum der Universität

Hamburg.

#### Additional abbreviations

D = shell diameter; H = shell height; leg. = collected by; V. = Vilayet.

<sup>&</sup>lt;sup>1</sup> Zoologisches Institut und Zoologisches Museum der Universität Hamburg, Martin-Luther-King-Platz 3, D-20146 Hamburg, Germany.

#### TAXONOMIC DESCRIPTIONS

#### CLAUSILIIDAE

Genus Elia (Acroeuxina) O. Boettger, 1877

Clausilia (Euxina [Acroeuxina]) O. Boettger, 1877: 85. Type species Clausilia huebneri L. Pfeiffer, 1848.

Acroeuxina has been included in Elia H. & A. Adams, 1855 as a subgenus by Nordsieck (1975). There are only conchological differences between Elia sensu stricto and Acroeuxina (Neubert 1993). Nordsieck (1994) stated that the epiphallus of Acroeuxina is longer than the epiphallus of Elia sensu stricto. However, a comparison of the genitalia of Elia sensu stricto (Neubert 1993: Fig. 49–51; Nordsieck 1975: Fig. 9) and the genitalia of the Acroeuxina species (Table 1) shows that this is not a constant difference.

Beside the type species *E. huebneri* (L. Pfeiffer, 1848), *E. retowskii* H. Nordsieck, 1984 and *E. laevestriata* (Retowski, 1887) were included in *Acroeuxina*. Furthermore, Neubert (1993) provisionally transferred *Euxina tuschetica* Likharev & Lejava, 1961 to *Acroeuxina*. However, this species does not have the very acutely tapering protoconch, which is an autapomorphy of *Acroeuxina*. According to Neubert (1993), an additional difference between *Acroeuxina* and *Elia sensu stricto* is the development of the lunella, which is connected with the upper palatalis in *Acroeuxina*, but not in *Elia sensu stricto*. The lunella of *E. tuschetica* is not connected with the upper palatalis (Likharev 1962). Moreover, *E. tuschetica* has an externally visible flagellum (Likharev 1962), whereas there is no externally visible flagellum in *Acroeuxina*. According to Neubert (1993), there is also no externally visible flagellum in *Elia sensu stricto*, whereas Nordsieck (1975: Fig. 9) figured an externally visible flagellum in *Elia sensu stricto*. Neither Neubert (1993) nor Nordsieck (1994) discussed that discrepancy. In any case *E. tuschetica* is not closely related with *Acroeuxina*.

The genitalia of all *Acroeuxina* taxa were examined and measured (Table 1). No constant differences in the proportions of the various sections of the genitalia were found between the species. The differences implied in the descriptions of the genitalia of *E. huebneri* and *E. retowskii* by Neubert (1993) are not species specific. The penis of the examined specimens of *E. laevestriata* (Retowski) was distinctly more inflated than the penis of the other species.

#### Elia (Acroeuxina) huebneri huebneri (L. Pfeiffer, 1848)

Clausilia Hübneri L. Pfeiffer, 1848: 473. Locus typicus: "Brussa", Turkey. Clausilia Huebneri, — Rossmässler, 1856: 73, pl. 79 Fig. 890. Clausilia (Euxina) Hübneri, — Retowski, 1887: 40. Laciniaria (Euxina) huebneri, — Loosjes, 1953: 31. Euxina (Acroeuxina) huebneri, — Zilch, 1960: 417, Fig. 1486. Elia (Acroeuxina) huebneri, —Neubert, 1993: 75 [partim], text-Fig. 52, pl. 10 Fig. 5. Elia (Acroeuxina) huebneri, — Bank & Menkhorst, 1994: 101, pl. 3 Fig. 19.

Holotype Bursa, V. Bursa, PE75 (SMF 73546).

Type locality Bursa, V. Bursa, Turkey.

Table 1
Measurements of some sections of the genitalia of the *Elia (Acroeuxina)* taxa (in mm). Abbreviations ep = epiphalus; div = diverticulum of the bursa copulatrix; fod = free oviduct; p = penis; ped = pedunculus + bursa of the bursa copulatrix; vag = vagina

	p	ep	ep:p	vag	fod	ped	div
E. h. huebneri							
Kapısu	2.1	6.2	3.0	3.5	1.0	10.2	3.0
4km E of Cide	2.6	9.4	3.6	4.5	1.5	16.8	5.0
4km E of Cide	2.0	5.0	2.5	3.7	1.3	13.0	5.2
E. h. interior							
2km W of Pınarbaşi	1.0	6.4	6.4	2.8	0.9	7.8	2.5
2km W of Pınarbaşi	3.1	10.0	4.3	2.5	1.7	9.0	2.9
E. h. concava							
2km W of Azdavay	2.1	7.0	3.3	3.7	0.8	12.0	4.5
E. laevestriata							
Amasra, town wall	2.0	5.5	2.8	3.8	1.3	8.0	3.1
Amasra, town wall	1.0	4.0	4.0	1.7	0.9	9.0	3.5
Amasra, town wall	1.8	5.3	2.9	4.0	1.1	10.8	3.0
E. r. retowskii							
Kapısu	4.0	12.0	3.0	5.5	2.3	17.0	6.0
Kapısu	3.5	11.5	3.3	5.2	2.3	20.0	5.0
Kapısu	3.3	13.0	3.9	5.5	2.1	15.5	5.5
Kumluca	2.5	11.5	4.6	4.0	2.5	12.0	4.5
E. r. levata							
2.5km E of Pınarbaşi	2.5	10.0	4.0	4.3	2.0	14.5	6.0
2.5km E of Pınarbaşi	2.3	11.5	5.0	5.0	2.0	16.0	6.0

Other Material V. Istanbul Istanbul, (SMF 30729); Rumeli Hisarı, PF75 (IZPAN; MEN; NNM; SMF 265390, 318810). V. Zonguldak Abas 20 km W of Zonguldak UL88 (HAU; Kozlu); UL98 (HAU); Safranbolu, 350 m, VL76 MEN; NNM; Safranbolu towards Amasra NNM; Hisarönü, VM10 (HAU); Amasra 0.5 km towards Bartın, VM42 (HAU); Çakraz 5 km towards Amasra, VM52 (HAU); Kapısu, VM73 (HAU; ZIM 2653); cave east of Gelik, 150 m (Loosjes, 1953). V. Kastamonu Kapısu 3.5 km towards Cide, VM83 (HAU); Cide 11 km towards Amasra, VM93 (HAU); Kumluca 4 km W of Cide, VM93 (HAU). V. Samsun Kavak, BF55 (SMF 73547, 75548).

*Measurements* Abas (n = 30): D: 3.3–3.7 mm,  $\bar{x}$  = 3.5 mm; H: 13.6–15.3 mm,  $\bar{x}$  = 14.2 mm; D/H: 0.232–0.273,  $\bar{x}$  = 0.247; Cide 4 km towards Inebolu (n = 30): D: 4.4–5.0 mm,  $\bar{x}$  = 4.7 mm; H: 16.7–19.9 mm,  $\bar{x}$  = 18.2 mm; D/H: 0.234-0.277,  $\bar{x}$  = 0.257.

Shell (Fig. 1) fusiform; spire very acutely tapering; 9<sup>1</sup>/<sub>2</sub>–11 slightly convex whorls;

bright corneus to corneus-brown; teleoconch coarsely ribbed (7–13 ribs/2 mm of the penultimate whorl); ribs with white touch; cervix convex; basal furrow distinct; basal keel low, rounded; aperture oval; peristome detached and protruding, slightly expanded, reflexed and weakly thickened at the inside; parietalis extending about 1/4 whorl into the shell; spiralis starting slightly before or behind the apical end of the parietalis; columellar edge slightly protruding; columellaris angular, reflexed inwards; subcolumellaris deeply situated, rather straight; lunella dorsally situated, connected with the long basalis and the upper palatalis; middle palatalis short or missing; upper palatalis extending forward as wide as the principalis; both folds are long and slightly diverging; clausilium hardly visible.

Distribution (Fig. 8) E. h. huebneri is spread in the coastal region of the Black Sea from Bursa and Istanbul in the west to Kavak in the V. Samsun in the east at least. The record from Ankara (Neubert 1993: 76) is due to a mistake (Neubert, personal communication). The record from Aşkale in the V. Erzurum (Neubert 1993: 75; NNM) is also probably due to a mistake. It is very improbable that the distribution area of Acroeuxina extends as far eastwards, since no Acroeuxina have been found in the intermediate area. The sample from Aşkale is from an expedition during which E. h. huebneri was collected also near Safranbolu. Perhaps, the label of a sample from the V. Zonguldak was exchanged with a label of a sample from the V. Erzurum.

The diagnostic characteristics of *E. h. huebneri* are summarized in Table 2. There are two samples from Safranbolu (V. Zonguldak). One of these samples (MEN) contains typical E. h. huebneri, whereas the other sample (NNM) contains some specimens intermediate between E. h. huebneri and E. h. concava: these specimens are finer ribbed, the columellaris is arched and the basalis is shorter.

#### Elia (Acroeuxina) huebneri interior n. subsp.

Elia (Acroeuxina) huebneri, —Neubert, 1993: 75 [partim, non L. Pfeiffer, 1848].

Holotype 2 km towards Ulus, V. Kastamonu, Pınarbaşi, exposed rocks near hamlet north of the road, WM00, leg. B. Hausdorf 29.09.1987, (ZIM 2654), measurements: D = 4.0 mm, H = 16.5 mm.

V. Kastamonu, Pınarbaşi 2 km towards Ulus, exposed rocks near hamlet *Paratypes* north of the road, WM00 (HAU, NHMW & ZIM 2655). 2 km towards Ulus, shady rocks near hamlet south of the road, WM00 (HAU & ZIM 2656). 2.5 km towards Azdavay, shady rocks, WM00 (HAU).

Type locality Ulus, V. Kastamonu, Pınarbaşi, Turkey

Measurements Pınarbaşi 2 km towards Ulus, exposed rocks (n = 30): D: 3.5–4.1 mm,  $\bar{x}$ = 3.8 mm; H: 14.2–17.4 mm,  $\bar{x}$  = 15.5 mm; D/H: 0.216–0.267,  $\bar{x}$  = 0.243; Pinarbasi 2 km towards Ulus, shady rocks (n = 30): D: 3.0–3.8 mm,  $\bar{x}$  = 3.4 mm; H: 11.0–16.6 mm,  $\bar{x}$  = 13.2 mm; D/H: 0.229–0.291,  $\bar{x} = 0.259$ .

(Fig. 2–3) fusiform; spire very acutely tapering; 9–11<sup>3</sup>/<sub>4</sub> slightly convex whorls; corneus-brown; teleoconch coarsely ribbed (3–10 ribs/2 mm of the penultimate whorl); ribs with white touch; cervix convex or slightly concave; basal furrow distinct; basal keel low, rounded; aperture oval; peristome detached and protruding, slightly expanded, reflexed and weakly thickened at the inside; parietalis extending about 1/4 whorl into

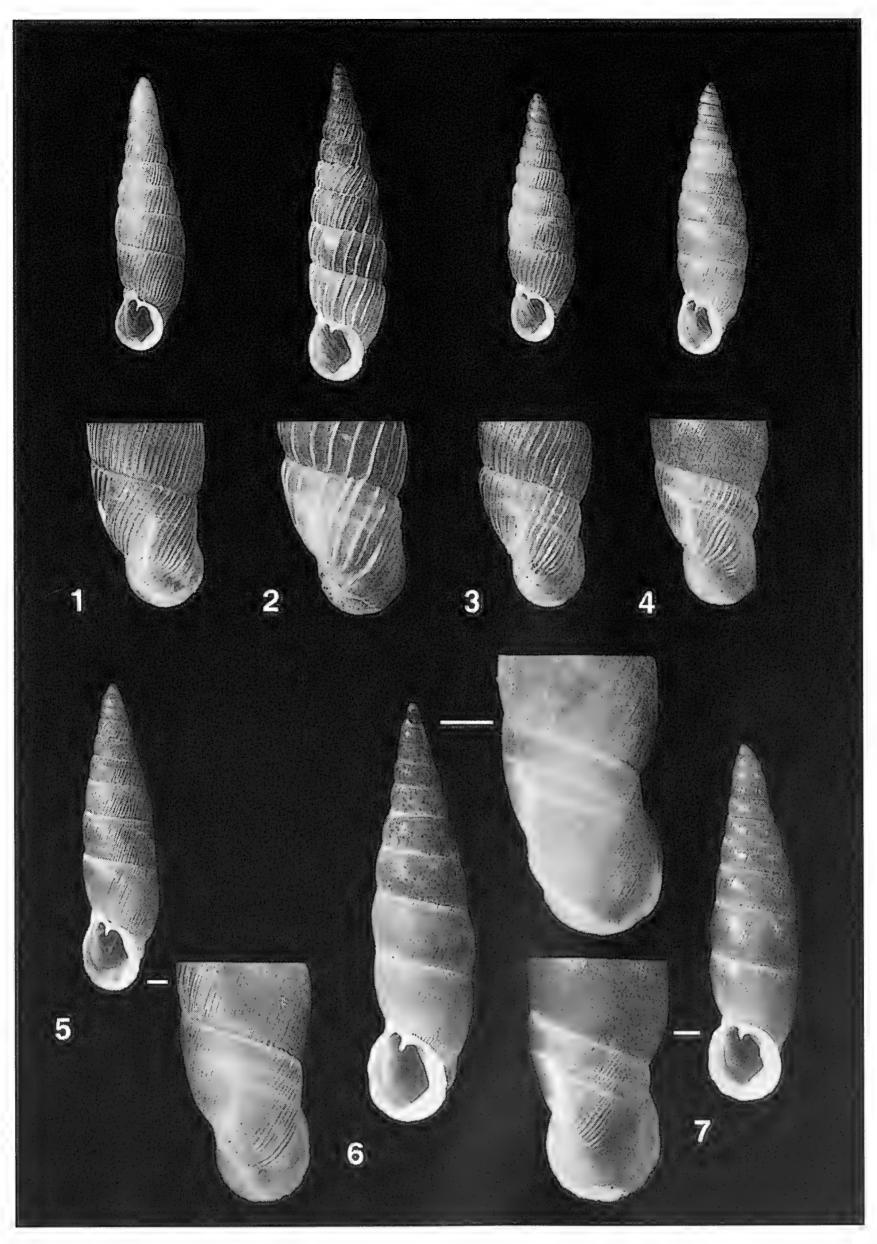


Fig. 1 Elia (Acroeuxina) huebneri huebneri (L. Pfeiffer, 1848). V. Zonguldak: Kapısu (ZIM 2653) Figs. 2–3 Elia (Acroeuxina) huebneri interior n. subsp. 2, V. Kastamonu: Pınarbaşi 2 km towards Ulus, exposed rocks (holotype ZIM 2654). 3, V. Kastamonu: Pınarbaşi 2 km towards Ulus, shady rocks (ZIM 2656) Fig. 4 Elia (Acroeuxina) huebneri concava n. subsp. V. Kastamonu: Azdavay 2 km towards Ulus (holotype ZIM 2657) Fig. 5 Elia (Acroeuxina) laevestriata (Retowski, 1887). V. Zonguldak: Amasra, rocks on peninsula (ZIM 2659) Fig. 6 Elia (Acroeuxina) retowskii retowskii H. Nordsieck, 1984. V. Zonguldak: Kapısu (ZIM 2660) Fig. 7 Elia (Acroeuxina) retowskii levata n. subsp. V. Kastamonu: Pınarbaşi 2.5 km towards Azdavay (holotype ZIM 2661) Magnification: total shells x 3, cervix x 5.

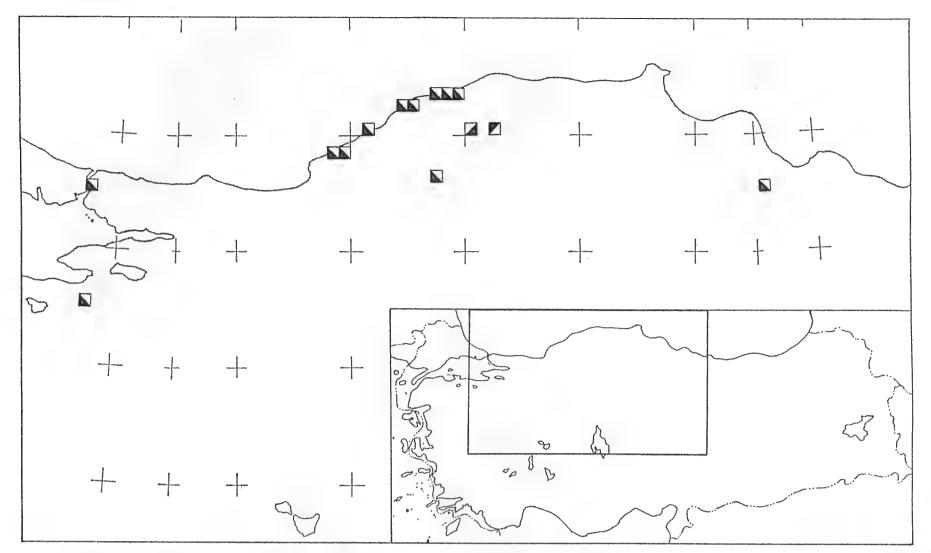


Fig. 8 Distribution map of *E. h. huebneri* (L. Pfeiffer) *E. huebneri interior* n. subsp. *E. huebneri concava* n. subsp. (UTM-grid, 10km squares)

the shell; spiralis starting slightly before or behind the apical end of the parietalis; columellar edge slightly protruding; columellaris angular, reflexed inwards; subcolumellaris deeply situated, rather straight; lunella dorsally situated, connected with the very short basalis and the upper palatalis; middle palatalis missing; upper palatalis not extending or extending forward as wide as the principalis; both folds are long and slightly diverging; clausilium hardly visible.

*Derivation of name* after the occurrence of the subspecies in the inland (lat. **interior** (adjective) = inland).

Distribution (Fig. 8) E. huebneri interior is known only from the environments of Pınarbaşi in the Vilayet Kastamonu.

Remarks The diagnostic characteristics of *E. huebneri interior* are summarized in Table 2. *E. huebneri interior* differs from the nominotypical subspecies in the very short basalis and the consistently missing middle palatalis. It is rather unusual that a subspecies from a more arid inland habitat has a weaker armature than a subspecies from a moist coastal region.

At the hamlet 2 km W of Pinarbaşi there are two groups of rocks: the one north of the road is exposed and dry, whereas the one south of the road is shady and moister. The two groups of rocks are less than 100 m apart. Nevertheless, the two forms of *E. huebneri* living on them are quite distinct. The form from the exposed rocks (Fig. 2) is distinctly more widely ribbed (3–5 ribs/2 mm of the penultimate whorl,  $\bar{x} = 4.0$ , n = 10) and larger (see measurements) than the form from the shady rocks (Fig. 3) (6–9 ribs/2 mm of the penultimate whorl,  $\bar{x} = 7.5$ , n = 10). If the two forms were to live in more remote localities, they would probably be separated as subspecies. But this case raises the question to which extent the rib-density is genetically fixed. If the rib-density would be determined mainly directly by environmental factors, forms with different rib-densities, which are usually regarded as subspecies, especially in the clausiliids, would be

simple modifications. If, on the other hand, the rib-density would be determined mainly genetically, either the gene flow between the two demes on the neighboring rock groups must be strongly reduced or there must be a strong selection for an adapted rib-density. That gene flow among demes of rock-dwelling clausiliids on separate boulders is actually extremely limited, making it unlikely to act as a homogenizing force at spatial scales larger than a few tens of metres, has been shown in *Albinaria corrugata* from Crete by Schilthuizen & Lombaerts (1994). It might be interesting to study the genetics of rib-density in *Elia huebneri interior* by cross-breeding the two differently ribbed forms and to examine the gene flow between the demes on the two rock groups with genetic markers.

The population from Pınarbaşi 2.5 km towards Azdavay leads over to *E. huebneri concava* by the slightly convex cervix.

#### Elia (Acroeuxina) huebneri concava n. subsp.

Elia (Acroeuxina) huebneri, —Neubert, 1993: 75 [partim, non L. Pfeiffer, 1848]. Elia (Acroeuxina) retowskii, —Neubert, 1993: 76 [partim, non H. Nordsieck, 1984].

*Holotype* Azdavay 2 km towards Ulus, V. Kastamonu, rocks at the west side of the river Çadak (ZIM 2657) leg. B. Hausdorf 29.09.1987, measurements: D = 3.7 mm, H = 14.3 mm.

Paratypes Azdavay 2 km towards Ulus, V. Kastamonu, rocks at the west side of the river Çadak, WM20 (HAU; IZPAN; NHMW; ZIM 2658).

Type locality Azdavay 2 km towards Ulus, V. Kastamonu, Turkey.

*Measurements* Azdavay, 2 km towards Ulus (n = 30): D: 3.6–4.0 mm,  $\bar{x}$  = 3.9 mm; H: 12.8–16.0 mm,  $\bar{x}$  = 14.4 mm; D/H: 0.226–0.302,  $\bar{x}$  = 0.268.

Shell (Fig. 4) fusiform; spire very acutely tapering; 10–12¹/₂ slightly convex whorls; bright corneus; upper whorls of the teleoconch coarsely ribbed, lower whorls finely ribbed; cervix slightly concave; basal furrow distinct; basal keel low, rounded; aperture oval; peristome detached and protruding, slightly expanded, reflexed and weakly thickened at the inside; parietalis extending about ¹/₄ whorl into the shell; spiralis starting slightly before the apical end of the parietalis; columellar edge slightly protruding; columellaris arched, reflexed inwards; subcolumellaris deeply situated, rather straight; lunella dorsally to dorsolaterally right situated, connected with the very short basalis and the upper palatalis; middle palatalis generally missing, rarely rudimentary; upper palatalis extending forward as wide as the principalis; both folds are long and slightly diverging; clausilium partly visible.

Derivation of name because of the concave (lat. concavus) cervix.

Distribution (Fig. 8) E. huebneri concava is known only from the inland of the Vilayet Kastamonu.

*Remarks* The diagnostic characters of *E. huebneri concava* are summarized in Table 2. *E. huebneri concava* differs from the neighboring *E. huebneri interior* in the finer sculpture and the arched columellaris.

Table 2
Diagnostic characteristics of the Elia (Acroeuxina) taxa

	E. h. huebneri	E. h. interior	Е. h. сопсаvа	E. laevestriata	E. r. retowskii	E. r. levata
lower whorls	coarsely ribbed	coarsely ribbed	finely ribbed	striated or finely ribbed	finely ribbed	only with growth ridges or striated
cervix	convex	slightly concave or convex	slightly concave	convex	convex	convex
basal furrow	distinct	distinct	distinct	distinct	missing	missing
basal keel	low, rounded	low, rounded	low, rounded	low, rounded	high, compressed high, compressed	high, compressed
aperture	oval	oval	oval	oval	oval	circular
columellaris	angular	angular	arched	angular	arched	angular
lunella	dorsally	dorsally	dorsally to dorsolaterally right	dorsally	dorsolaterally right	dorsolaterally right
basalis	long	very short	short	long	very short	very short
middle palatalis	short or missing	missing	generally missing	weak or missing	missing	missing
upper palatalis	extending forward as wide as the principalis	extending or not extending forward as wide as the principalis	extending forward as wide as the principalis	extending forward as wide as the principalis	not extending forward as wide as the principalis	not extending forward as wide as the principalis
measurements DxH in mm.	3.3-5.0 x 13.6-19.9	3.0-4.1 x 11.0-17.4	3.7-4.0 x 12.8-16.0	3.9-4.7 x 13.9-18.9	4.4-6.0 x 16.0-25.7	4.6-5.4 x 17.7-22.4

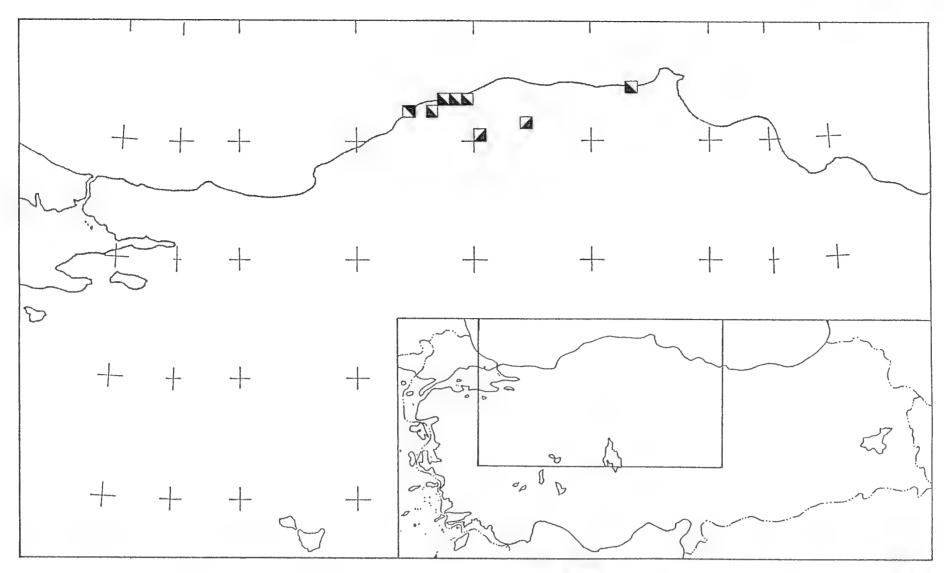


Fig. 9 Distribution map of *E. laevestriata* (Retowski) E. r. retowskii H. Nordsieck E. r. levata n. subsp. (UTM-grid, 10km squares)

#### Elia (Acroeuxina) laevestriata (Retowski, 1887)

Clausilia (Euxina) laevestriata Retowski, 1887: 40, pl. 1 Fig. 2. Locus typicus: unknown (debris of the Black Sea at the coast of the Crimea near Dwoch Jakarnij). Elia (Acroeuxina) retowskii, — Neubert, 1993: 76 [partim, non H. Nordsieck, 1984].

Material examined Amasra, V. Zonguldak, town-wall, VM42 (HAU); Amasra, rocks on peninsula, VM42 (HAU; ZIM 2659).

*Measurements* Amasra, rocks on peninsula (n = 30): D: 3.9–4.7 mm,  $\bar{x}$  = 4.2 mm; H: 13.9-18.9 mm,  $\bar{x}$  = 16.1 mm; D/H: 0.243-0.285,  $\bar{x}$  = 0.264.

Shell (Fig. 5) fusiform; spire very acutely tapering; 8 <sup>1</sup>/2–10 <sup>3</sup>/4 slightly convex whorls; corneus-brown; upper whorls of the teleoconch coarsely ribbed, lower whorls striated or finely and densely ribbed; cervix convex; basal furrow distinct; basal keel low, rounded; aperture oval; peristome detached and protruding, slightly expanded, reflexed and weakly thickened at the inside; parietalis extending about <sup>1</sup>/4 whorl into the shell; spiralis starting slightly before the apical end of the parietalis; columellar edge slightly protruding; columellaris angular, reflexed inwards; subcolumellaris deeply situated, rather straight; lunella dorsally situated, connected with the rather long basalis and the upper palatalis; middle palatalis weak or missing; upper palatalis extending forward as wide as the principalis; both folds are long and slightly diverging; clausilium partly visible.

Distribution (Fig. 9) E. laevestriata is known only from Amasra in the Vilayet Zonguldak.

Remarks The diagnostic characters of E. laevestriata are summarized in Table 2. E. laeve-

striata resembles especially *E. huebneri concava* by the combination of a rather weak sculpture with a distinct basal furrow and a low, rounded basal keel. However, it differs from that subspecies in the concave cervix, the angular columellaris and the very short basalis. Both taxa are probably not closely related, but evolved independently from isolates of the *huebneri*-stock. *E. laevestriata* is probably distinct from *E. huebneri*, because it lives in the range of *E. h. huebneri*, where no transitional forms between the two species occur and because *E. laevestriata* differs anatomically from *E. huebneri* in the inflated penis.

The form from Amasra differs from the holotype of *E. laevestriata* (IZPAN) only in the slightly coarser sculpture and the more angular columellaris.

#### Elia (Acroeuxina) retowskii retowskii H. Nordsieck, 1984

Elia (Acroeuxina) retowskii H. Nordsieck, 1984: 203, pl. 12 Fig. 15. Locus typicus: "Ayancik", Turkey.

Elia (Acroeuxina) retowskii, -Neubert, 1993: 76 [partim], text-Fig. 53, pl. 10 Fig. 6.

Holotype Ayancık, V. Sinop, XM34 (SMF 271971).

Paratypes Ayancık, V. Sinop, XM34 (SMF 271972).

Type locality Ayancık, V. Sinop, Turkey.

Other Material V. Zonguldak Kalaycı 2.5 km towards Cide, VM62 (HAU); Kapisu, VM73 (HAU; ZIM 2660). V. Kastamonu Kapısu 3.5 km towards Cide, VM83 (HAU); Cide 11 km towards Amasra, VM93 (HAU); Kumluca 4 km W of Cide, VM93 (HAU; NHMW).

*Measurements* Cide 11 km towards Amasra (n = 30): D: 5.4–6.0 mm,  $\bar{x}$  = 5.7 mm; H: 21.3–25.7 mm,  $\bar{x}$  = 23.2 mm; D/H: 0.220–0.271,  $\bar{x}$  = 0.245; Kumluca (n = 30): D: 4.4–5.0 mm,  $\bar{x}$  = 4.7 mm; H: 16.0–20.2 mm,  $\bar{x}$  = 17.6 mm; D/H: 0.246–0.292,  $\bar{x}$  = 0.266.

Shell (Fig. 6) fusiform; spire very acutely tapering; 9–11¹/2 slightly convex whorls; corneus-brown; teleoconch finely and densely ribbed; cervix convex; without basal furrow; basal keel high, compressed; aperture oval; peristome detached and protruding, slightly expanded, reflexed and weakly thickened at the inside; parietalis extending about ¹/4 whorl into the shell; spiralis starting slightly before or behind the apical end of the parietalis; columellar edge slightly protruding; columellaris arched, reflexed inwards; subcolumellaris deeply situated, rather straight; lunella dorsolaterally right situated, connected with the very short basalis and the upper palatalis; middle palatalis missing; upper palatalis not extending forward as wide as the principalis or foremost part of the upper palatalis rather low; both folds are long and slightly diverging; clausilium hardly visible.

*Distribution* (Fig. 9) *E. r. retowskii* is spread along the coast of the Black Sea from Kalaycı east of Amasra in the west to Ayancık in the east at least. It lives sympatrically with *E. h. huebneri* at several localities.

Remarks The diagnostic characteristics of *E. r. retowskii* are summarized in Table 2. *E. retowskii* is especially characterized by the absence of the basal furrow, the high, compressed basal keel and the dorsolaterally right situated lunella.

#### Elia (Acroeuxina) retowskii levata n. subsp.

Elia (Acroeuxina) retowskii, -Neubert, 1993: 76 [partim, non H. Nordsieck, 1984].

*Holotype* Pınarbaşi 2.5 km towards Azdavay, V. Kastamonu, WM00 (ZIM 2661) leg. B. Hausdorf 29.09.1987, measurements: D = 4.6 mm, H = 18.0 mm; (HAU; NHMW; ZIM 2662).

Paratypes Ağlı 2 km towards Kastamonu, V. Kastamonu, WM41 (HAU; IZPAN).

*Measurements* Pınarbaşi 2.5 km towards Azdavay (n = 30): D: 4.6–5.4 mm,  $\bar{x}$  = 5.0 mm; H: 17.7-22.4 mm,  $\bar{x}$  = 19.3 mm; D/H: 0.227-0.273,  $\bar{x}$  = 0.256.

Shell (Fig. 7) fusiform; spire very acutely tapering; 9 ³/4–12 ¹/4 slightly convex whorls; corneus-brown; upper whorls of the teleoconch often finely ribbed, lower whorls only with growth-ridges or irregularily striated; cervix convex; without basal furrow; basal keel high, compressed; aperture circular; peristome detached and protruding, slightly expanded, reflexed and weakly thickened at the inside; parietalis extending about ¹/4 whorl into the shell; spiralis starting behind the apical end of the parietalis; columellar edge slightly protruding; columellaris angular, reflexed inwards; subco-lumellaris deeply situated, rather straight; lunella dorsolaterally right situated, connected with the very short basalis and the upper palatalis; middle palatalis missing; upper palatalis not extending forward as wide as the principalis or foremost part of the upper palatalis rather low; both folds are long and slightly diverging; clausilium hardly visible.

*Derivation of name* because of the almost smooth shell (lat. **levare** = to smooth).

Distribution (Fig. 9) E. retowskii levata is known only from the inland of the Vilayet Kastamonu.

Remarks The diagnostic characters of *E. retowskii levata* are summarized in Table 2. *E. retowskii levata* differs from *E. r. retowskii* in the smoother shell, the circular aperture and the angular columellaris.

#### **ACKNOWLEDGEMENTS**

I am grateful to Prof. Dr. E. Gittenberger (NNM), Dr. R. Janssen (SMF), H. P. M. G. Menkhorst (Krimpen/Ijssel) and Prof. Dr. A. Riedel (IZPAN) for the loan of material, to G. Lindner (Hamburg) for his help in taking the photos and to M. Hingston (Hamburg) for correcting the English text.

#### **REFERENCES**

Bank R.A. & Menkhorst H.P.M.G. 1994 Katalog der rezenten Clausiliidae (exkl. Gattung *Albinaria*) der Türkei (Gastropoda, Pulmonata) *DEINSEA* 1: 85–122.

BOETTGER O. 1877 Clausilienstudien Palaeontographica N.F., Suppl. 3: 1–122, pl. 1–4.

- Kerney M.P. & Cameron R.A.D. 1979 A Field Guide to the Land Snails of Britain and North-west Europe. Collins, London 288 pp., 24 pl.
- LIKHAREV I.M. 1962 Klauziliidy (Clausiliidae). In Fauna SSSR, Molljuski, III (4) Moskva and Leningrad 317 pp.
- Loosjes F.E. 1953 Malakologische Resultate einer Reise nach der asiatischen Türkei. 3. Clausilien-Ausbeute des Herrn H. W. E. Croockewit aus der asiatischen Türkei, Umgebung von Zonguldak *Basteria* 17: 28–31.
- Neubert E. 1993 Systematik der Unterfamilie Clausiliinae (Mollusca, Gastropoda, Clausiliidae) unter besonderer Berücksichtigung der Mentissoideinae sensu Nordsieck, 1979. Dissertation. Technische Hochschule Darmstadt. II+135+40 pp., 12 pl.
- NORDSIECK H. 1975 Zur Anatomie und Systematik der Clausilien, XVI. Zur Kenntnis der Mentissoideinae und kaukasischen Baleinae *Archiv für Molluskenkunde* **106**: 81–107.
- Nordsieck H. 1984 Neue Taxa rezenter europäischer Clausilien, mit Bemerkungen zur Bastardierung bei Clausilien (Gastropoda: Clausiliidae) Archiv für Molluskenkunde 114: 189–211.
- NORDSIECK H. 1994 Türkische Clausiliidae, II: Neue Taxa der Unterfamilien Serrulininae und Mentissoideinae in Anatolien (Gastropoda: Stylommatophora) Stuttgarter Beiträge zur Naturkunde, Serie A 513: 1–36.
- Pfeiffer L. 1848 Monographia Heliceorum viventium. 2 Brockhaus, Lipsiae 594 pp.
- Retowski O. 1887 Am Strande der Krim gefundene angeschwemmte Binnenconchylien *Malakozoologische Blätter N.F.* 9: 22–42, pl. 1.
- ROSSMÄSSLER E.A. 1856 Iconographie der Land- und Süsswasser-Mollusken Europa's **3 (3/4)**: VIII + 41–77, pl. 71–80. Constenoble, Leipzig.
- Schilthuizen M. & Lombaerts M. 1994 Population structure and levels of gene flow in the mediterranean land snail *Albinaria corrugata* (Pulmonata: Clausiliidae) *Evolution* 48 577–586.
- ZILCH A. 1960 Euthyneura In Schindewolf O.H. (ed.) Handbuch der Paläozoologie 6 (2,3): 401–600 Gebrüder Borntraeger, Berlin.

## A NEW SPECIES OF AMMONICERA (OMALOGYRIDAE, ALLOGASTROPODA) FROM BRAZIL

Luiz Ricardo L. Simone<sup>1</sup>

Accepted for publication, 20 February 1997

Abstract Ammonicera plana, a new species of Omalogyridae, is described from the infratidal zone of the north coast of São Paulo State, Brazil. Distinguishing shell characters are; five dark spiral bands per whorl; great lateral compression; poor development of shell sculpture and the presence of a lateral spiral ridge. The anatomy is compared with that of the European Omalogyra atomus, from which it differs; in having mixed testis and ovarium; no large glands near the anus and in lacking vesicula seminalis. The anatomical data support the inclusion of the Omalogyridae in the Allogastropoda rather than in the euthyneuran Rissoelloidea.

Key words Ammonicera plana n. sp., Omalogyridae, Brazil, anatomy.

#### **INTRODUCTION**

The family Omalogyridae are amongst the most minute molluscs, rarely exceeding 1 mm and many half this size. Perhaps, because of their size they have only recently been the subject of more extensive study (Rolán, 1991, 1992, in particular for Atlantic species).

Omalogyrid anatomical data are even more scant, only Fretter (1948), for the European *Omalogyra atomus*, gives a comprehensive description. The systematic position has been discussed by Haszprunar (1985, 1988) using data from Fretter, 1948 and by Healy (1988) using sperm data. Haszprunar (1985) initially included the Omalogyridae in the Rissoelloidea but later (1988) suggested a relationship with the Allogastropoda. In particular, the lack of a true penis and the separation of the ovary and testis suggested an affinity with the Architectonicidae.

To date, only one species of Omalogyridae has been recorded from Brazilian waters: *Omalogyra planorbis* (Dall, 1927) in Rios, 1994: 181. This species was subsequently given a new generic placement in *Palazzia* (Warén, 1991). In studies on the fauna associated with the coral *Mussismilia hispida* (Verrill) carried out by João Miguel M. Nogueira (Doctoral thesis) on the north coast of São Paulo, specimens of an unusual omalogyrid were collected. Examination of the shell indicated that they were of an undescribed species of the genus *Ammonicera* Vayssière, 1893.

Despite the few specimens available the gross anatomy was examined which adds to the wider understanding of the family but does not yet resolve the problems with their phylogeny.

#### MATERIAL AND METHODS

Only eleven specimens were available and all were fixed in 4% formalin for one day and then preserved in 70% ethanol. After breaking the shells, two specimens were dehydrated in an ethanol series, stained in carmine, and fixed and cleared in creosote; these

<sup>&</sup>lt;sup>1</sup> Museu de Zoologia da Universidade de São Paulo, Caixa Postal 42694, 04299-970, São Paulo, Brazil.

were then dissected. Two specimens were decalcified in Railliet-Henry fluid, sectioned at  $4\mu$ m using standard histological techniques and then stained with Mallory's trichrome. Four specimens were dried and used for scanning electron microscopy of the shell and operculum in the Laborarório de Microscopia Eletrônica do IBUSP.

Shell terminology follows Rolán (1992) and anatomical terminology follows Fretter

(1948). All drawings were made using a camera lucida.

#### **SYSTEMATICS**

**O**MALOGYRIDAE

Genus *Ammonicera Ammonicera plana* n. sp.
Figs 1–14

Holotype MZUSP 28222

Paratypes 2 sp. on SEM stubs and 2 on histological slides, all from type locality, MZUSP 28225. 1 each from São Paulo, São Sebastião, Vitoria Island, 23°45′S 45°01′W, 08.i.1993, MZUSP 28211 and 28223. São Paulo, Ubatuba, Palmas Island, i.1993 MZUSP 28224.

Type locality Brazil, São Paulo State, Ubatuba city, Mar Virado Island, 23°30'S 45°25'W.

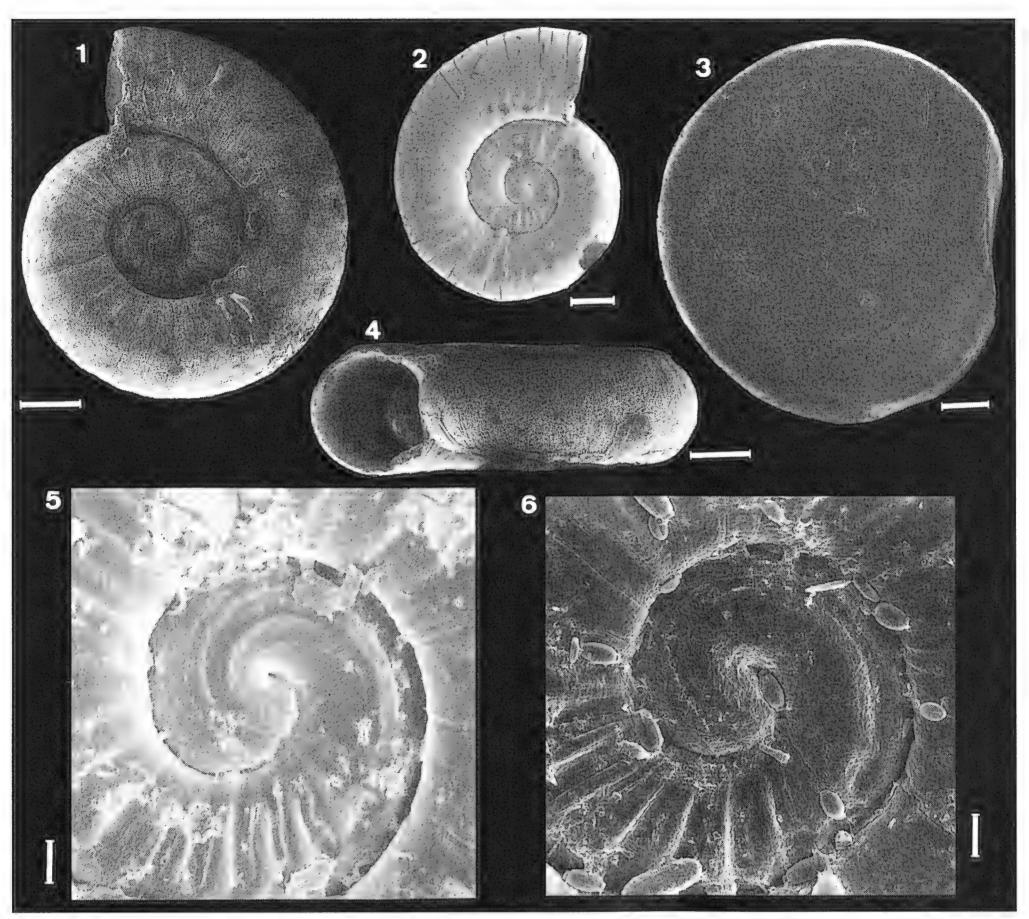
*Diagnosis* A sub-tidal species from south-east Brazil; shell with five coloured bands per whorl, lateral band generally marking a low spiral cord; spiral, axial sculpture and protoconch sculpture poorly developed; shell very laterally compressed.

Description Shell. Very small reaching 1mm in diameter, planispiral, biconcave, very laterally compressed (Figs 1, 2, 4), opaque, translucent. Yellow in colour with five brown spiral lines per whorl (Fig. 10), one on the periphery, two close to the suture and two in the mid lateral region. In some specimens these spiral lines are discretely elevated, appearing as low lateral chords (Figs 1, 2). Protoconch (Figs 5, 6) of about 3/4 of a whorl; a central depression bordered by low elevations; surface somewhat irregular. Teleoconch of up to two whorls, elongated. First whorl with about twenty axial ridges, irregularly spaced, and with minute spiral striae. Spiral and axial sculptures fade gradually by the beginning of the second whorl. Second whorl mostly smooth except for growth lines and undulations (Figs 1, 2). Aperture semi-circular (Fig. 4); lips simple.

Head-Foot. All structures without pigments, pale beige in colour, semi-transparent. Head proportionately small, not prominent, lacking tentacles (Figs 7,9,11). Eyes well developed, dark, on small protuberances of the head tegument (Fig. 11). Pair of cephalic lobes on anterior extremity of head (Fig. 12), long, tip rounded, dorso-ventrally flattened. Mouth lying between head and limits of foot and between lobes (Figs 12, 13). Foot proportionately small (Figs 9, 11, 13), without divisions. Anterior pedal gland small (Fig. 9). Posterior pedal gland very large, occupies foot and head up to the posterior region of the nerve ring (Figs 9, 13); its aperture a short tube in the middle region of the pedal sole. Columellar muscle proportionately short (Figs 9, 11, 13), with few but strong muscle fibres. All head-foot structures lie in the same sagittal plane of the shell (Fig. 11).

Operculum. Corneus, yellow, transparent, palcispiral, circular, and occupies entire aperture (Fig. 3).

Mantle. Mantle border simple, bifolded, without appendages (Figs 7, 8). Mantle cavity



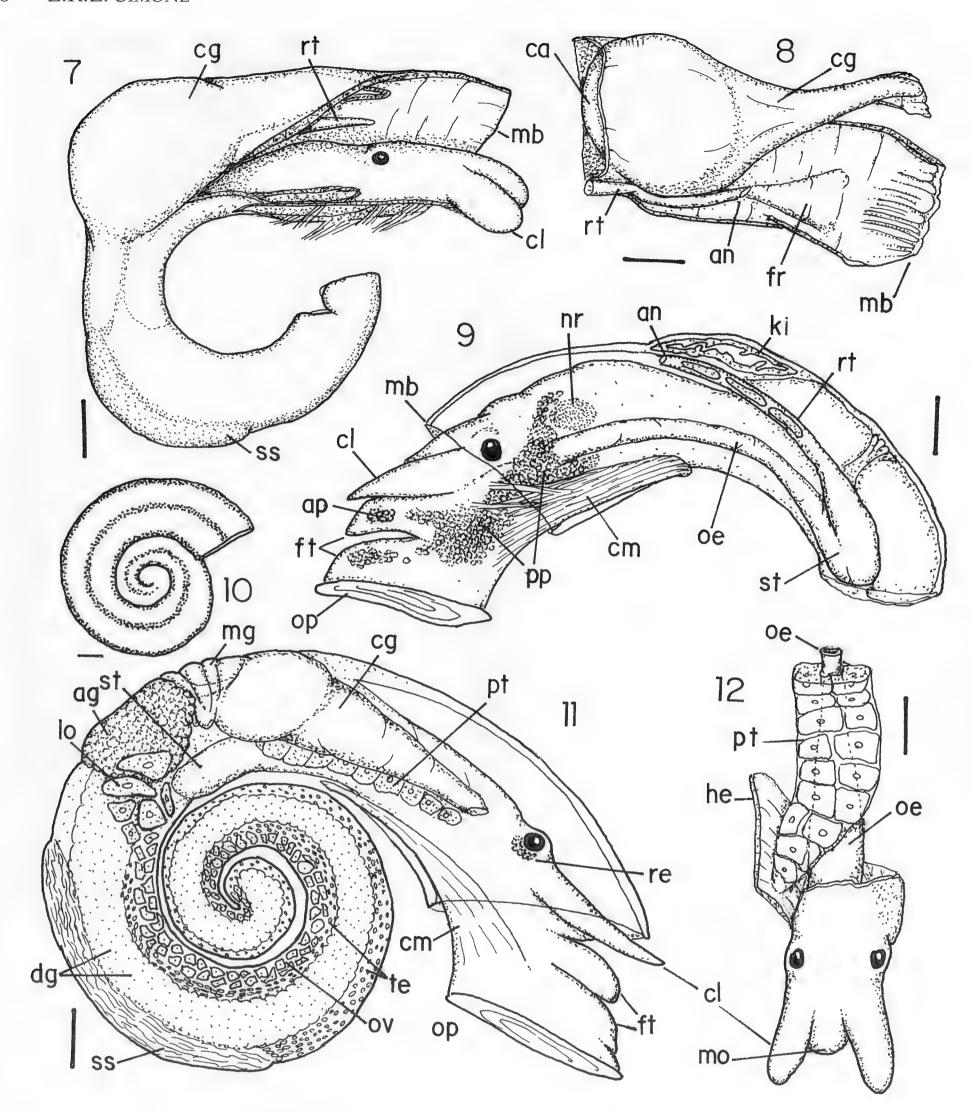
Figs 1-6 Ammonicera plana n. sp. Shell.

short, about half the length of the head-foot; lacking gills and osphradium or any other special gross structures (Figs 7, 8). Kidney and anus on the left side, genital ducts on right posterior region. When developed, female gonoducts occupying most of the cavity space. From the anus lies an expanding thickening of the mantle (Fig. 8, fr), in cross section appears as a series of small low ciliated folds and lies over a similar development of the head tegument (Fig. 14). Hypobranchial gland between rectum and genital ducts, small, flattened (Figs 13, 14).

Excretory-circulatory systems. Kidney proportionately small, with low folds and apparently hollow internally (Figs 9, 13, 14); situated far back in roof of pallial cavity (Fig. 9) on left of midline. Heart and vessels not seen.

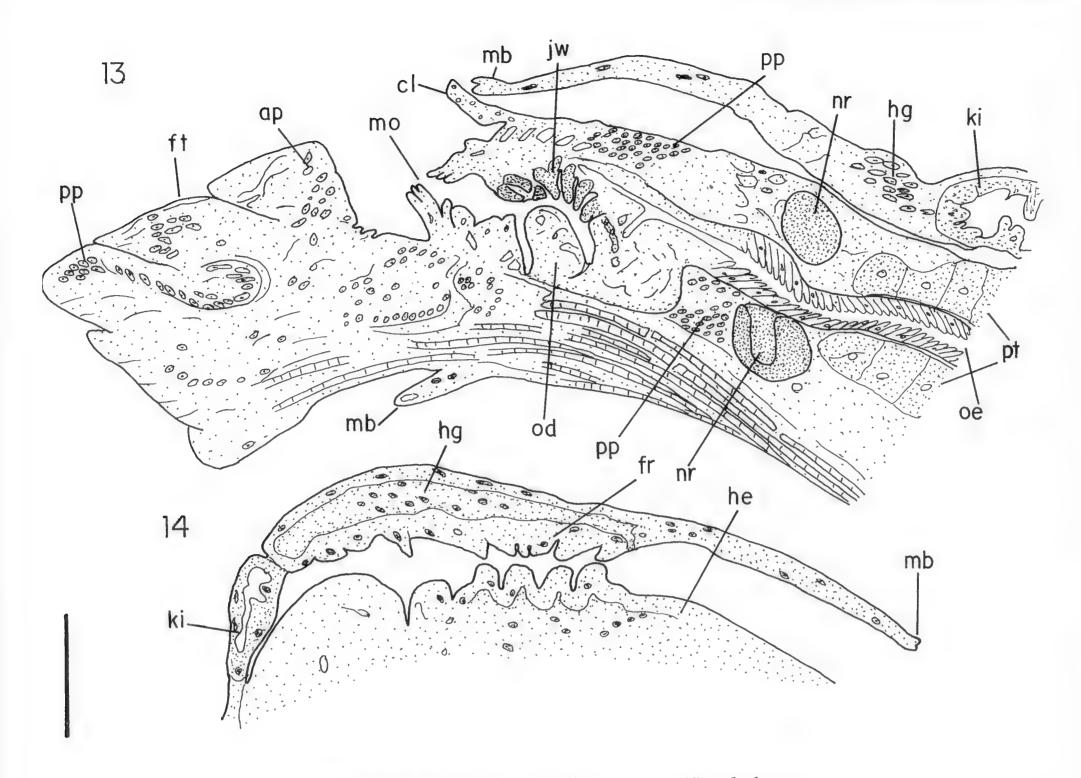
Digestive system. Mouth walls bulging anteriorly (Fig. 13), thick, muscular, covered internally by cuticle. This cuticle thickens dorsally as jaws in several plates (Fig. 13, jw). Odontophorical structures situated ventral to cuticle thickenings (Fig. 13, od). Radula not seen. Oesophagus proportionately long, dorso-ventrally flattened, inner surface with epithelium of tall ciliated cells sloping posteriorly (Fig. 13). Stomach in middle region of last whorl, ventral to albumen gland, U-shaped (Fig. 9), apparently without appendages. Intestine a simple tube, short, somewhat straight (Fig. 9). Anus relatively towards the rear of the pallial cavity (Figs 7, 8).

Genital system. Gonad occupying inner surface of all whorls from beginning into the



**Figs 7–12** *Ammonicera plana* n. sp. Head–foot.

posterior region of last whorl and accompanying digestive gland (Fig. 11). Female portion of gonad mainly concentrated on inner regions (Fig. 11, ov). Ovules becoming larger near albumen gland. Male portion of gonad mainly concentrated on lateral and external regions of each whorl, but also found in inner region where spermatids remain dorsally on the ovule zone (Fig. 11, te). Testis and ovarium anatomically mixed. Concentration of mature sperm in external region of last whorl as a sperm sac (Fig. 11, ss). Female glands lie from posterior region of last whorl to the head in the following sequence; concentration of large ova (lo); albumen gland hemispherical situated just dorsal of the stomach (ag); mucous gland small and folded (mg); capsule gland large (cg), rounded posteriorly, tapering gradually and situated in the right side of the pallial cavity between the roof and floor (Figs 7, 8); opens via a single pore posterior and ventral to the right eye (Fig. 11). Male glands indistinct, other than sperm sac (noted



Figs 13–14 Ammonicera plana n. sp. Head–foot.

above) there is only a mass of glandular tissue, of aligned very large cells, occupying most of the inner space of the posterior half of the haemocoel surrounding the oesophagus. This tissue is apparently prostate and follows the capsule gland ventrally (Figs 11, 12, pt); no aperture was found.

Development The specimens sectioned histologically were of differing sizes; a larger one with about three whorls and a smaller one with no more than two whorls. The larger was a simultaneous hermaphrodite with mature ova and sperm; the smaller had only testis but in small quantity around the digestive gland, mature sperm were present in the sperm sac, the prostate was developed but the female glands were immature. These observations suggest that *A. plana* begins as a male developing later into a simultaneous hermaphrodite.

Distribution Known only from the coast of São Paulo State, Brazil.

Habitat Crawling on the coral Mussismilia hispida at a depth of 5 m.

Derivation of name plana L. referring to the flattened nature of the shell.

#### **DISCUSSION**

Of the ten species of Omalogyridae recorded from the west Atlantic (Castellanos, 1988; Rolán, 1992; Rios, 1994) *Ammonicera plana* is similar only to *A. lineofuscata* Rolán, 1992 from Cuba. *Ammonicera plana* differs in having five , not three, coloured spiral bands; in the lateral bands marking a low spiral chord; in having weaker spiral and axial sculpture and in the protoconch which is less evident and more compressed laterally. Is there any chance that it could be an amphi-Atlantic species.

Despite the gross examination of the anatomy of *A. plana* some differences from *Omalogyra atomus* (Fretter, 1948) can be seen:

- 1) in *A. plana* the buccal mass is anterior to the nerve ring but contraction may account for this;
- 2) the large glands opening into the mantle cavity close to the anus in *O. atomus*, and mistaken for eggs by some (Lebour, 1937), are absent in *A. plana*;
  - 3) the vesicula seminalis is absent in *A. plana* but well developed in *O. atomus*;
- 4) In *A. plana* the testis and ovarium are anatomically mixed and completely associated with the digestive gland (Fig. 11) whereas in *O. atomus* they are separate and there is a free region of the digestive gland (see Fretter, 1948: 600, Fig. 2). The systematic implications of these differences cannot be assessed without the examination of many more species of omalogyrids.

Other than the small size and simultaneous hermaphroditism there are no other characters which justify the inclusion of the omalogyrids within the Rissoelloidea a superfamily associated with the Euthyneura (Simone, 1995). The gonoducts of omalogyrids, among several other characters, differ considerably from the rissoellids in that they run in the floor of the pallial cavity and not in the haemocoel. This feature occurs in several Allogastropoda and basal Opisthobranchia and supports the inclusion of the Omalogyridae in the Allogastropoda as advocated by Haszprunar (1988).

#### **ACKNOWLEDGEMENTS**

I thank Joao Miguel M. Nogueira for collecting the specimens; Dr. G. Haszprunar, Innsbruck University, Austria, and Dr W. Ponder, Australia, for correspondence; Dr. Jose H. Leal, Bailey Matthews Shell Museum, Florida and Dr. E. Rolan, Spain, for references.

#### **REFERENCES**

- Castellanos Z.A. 1988 Novedades sobre micromoluscos subantarticos (Mollusca, Gastropoda) *Neotropica* **36(92)**: 89–92.
- Fretter V. 1948 The structure and life history of some minute prosobranchs of rock pools: *Skeneopsis planorbis* (Fabricius), *Omalogyra atomus* (Philippi), *Rissoella diaphana* (Alder) and *Rissoella opalina* (Jeffreys) *Journal of the Marine Biological Association UK* 27: 597–632.
- Haszprunar G. 1985 The Heterobranchia, a new concept of the phylogeny of the higher Gastropoda Zeitschrift für Zoologische Systematik und Evolutionsforschung 23: 15–37.
- HASZPRUNAR G. 1988 On the origin and evolution of major gastropod groups, with special reference to the Streptoneura *Journal of Molluscan Studies* **54**: 367–441.
- Healy J.M. 1988 Sperm morphology and its systematic importance in the Gastropoda *Malacological Review supplement* **4**: 251–266.
- Lebour M.V. 1936 Notes on the eggs and larvae of some British prosobranchs *Journal of the Marine Biological Association UK* **20**: 547–565.

- Rios E.C. 1994 Seashells of Brazil second edition. Fundação Universidade do Rio Grande, Rio Grande 368 pp.
- ROLAN E. 1991 La familia Omalogyridae G.O. Sars, 1878 (Mollusca, Gastropoda) en el archipelago de Cabo Verde *Graellsia* 47: 105–116.
- ROLAN E. 1992 The family Omalogyridae G.O. Sars, 1878 (Mollusca, Gastropoda) in Cuba with descriptions of eight new species *Apex* **7(2)**: 35–46.
- SIMONE L.R.L. 1995 *Rissoella ornata*, a new species of Rissoellidae (Mollusca: Gastropoda: Rissoelloidea) from southeastern coast of Brazil *Proceedings of the Biological Society of Washington* **108(4)**: 560–567.
- Warrèn A. 1991 New and little known Mollusca from Iceland and Scandinavia *Sarsia* **76 (1–2)**: 53–124.

·			
			,

# TAXONOMY AND DESCRIPTIONS OF BIVALVES (LUCINOIDEA, GALEOMMATOIDEA, CARDITOIDEA, CARDIOIDEA, TELLINOIDEA & MYOIDEA) FROM THE ARABIAN SEA

P.G. Oliver<sup>1</sup> & H.C.G. Chesney<sup>2</sup>

Accepted for publication, 20 February 1997

Abstract Following the inclusion of uncertain taxa in the recently published "Seashells of Eastern Arabia" this paper partly resolves the situation by describing eight new species, one new subspecies and one new genus from the northern Arabian Sea and Arabian Gulf. The new species include additions to the following genera; Loripes (Lucinoidea), Sagamikellia (uncertain galeommatid) Carditopsis and Carditellopsis (Carditoidea), Lyrocardium and Trachycardium (Cardioidea), Moerella (Tellinoidea) and Cryptomya (Myoidea). The new subspecies is of Trachycardium impolitum and the new genus Aenictomya is placed in the Galeommatoidea.

Key words Taxonomy, Bivalvia, Arabian Sea.

#### **INTRODUCTION**

Preparations for the publication of Eastern Arabian Seashells (Dance 1995) led to the examination of considerable amounts of material from the relatively unexplored coasts of Oman. A number of new taxa and taxonomic problems were encountered and some work on the bivalves (Oliver & Chesney 1994, Chesney & Oliver 1994, Oliver & Glover 1996) was completed before publication. This paper continues this research programme.

#### TAXONOMIC DESCRIPTIONS

LUCINOIDEA LUCINIDAE

Genus *Loripes* Poli, 1791 Type species *Tellina lactea* Poli, 1791 = *Amphidesma lucinalis* Lamarck, 1818

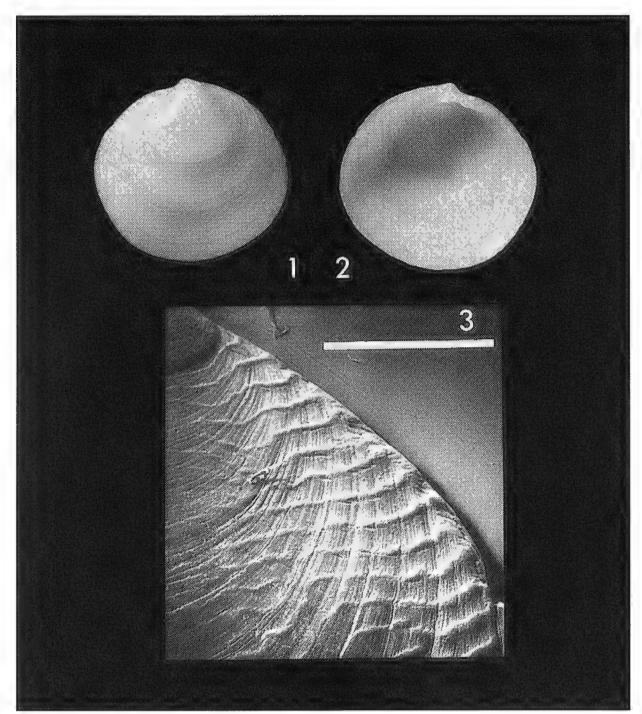
Loripes araiogramma n. sp. Figs 1–3

Lucinella sp. Oliver in Dance (ed.) 1995: 237, Fig. 1034.

*Holotype* Single rv, 2km East of Marbat, Dhofar, Southern Oman. 17°N 54.7°E. Leg. D. Bosch/S.P. Dance, NMW.Z. 1993.061.1717.

<sup>&</sup>lt;sup>1</sup> Dept. of Zoology, National Museum of Wales, Cathays Pk., Cardiff, CF1 3NP, Wales UK.

<sup>&</sup>lt;sup>2</sup> Dept. of Zoology, Ulster Museum, Botanic Gardens, Belfast, BT9 5AB, Ulster, UK.



Figs 1–3 Loripes ariogramma n. sp. Figs 1–2 Holotype, length = 16.7mm. Fig. 3 Sculpture on posterior margin SEM x35

Paratypes 6v, as Holotype, NMW.Z. 1993.061.1602 and 1718.

Type locality 2km East of Marbat, Dhofar, Southern Oman.

Description Shell to 20mm. Solid. Rather compressed. Equivalve. More or less equilateral with beaks very slightly behind midline. Outline lenticular just longer than high; anterior slightly expanded and rounded, posterior margin slightly straightening, dorsal margins indistinct. Lunule small, deeply sunken, narrowly cordate. Sculpture smooth except for sparse oblique lines on the posterior and anterior dorsal area. Hinge with 2 small cardinals in each valve; RV with single long posterior lateral and a pair of anterior laterals; LV with paired anterior and posterior laterals. Ligament large on a deeply sunken internal resilium. Anterior adductor scar relatively short, free for about half its length and slightly divergent. Inner margin apparently smooth but type series is rather worn. Shell white.

#### Measurements (mm)

	Length	Height	Tumidity (single valve)	Valve
Holotype	16.7	16.1	4.1	LV
Paratype	18.7	17.3	4.2	LV
Paratype	19.2	18.3	5.2	LV
Paratype	17.2	17.3	4.5	RV
Paratype	17.4	16.4	4.8	RV
Paratype	16.5	15.7	4.3	RV
Paratype	broken	15.0	4.3	RV

Derivation of name araiogramma from the Greek, araios, few and gramma, a line and referring to the sculpture.

Distribution Known only from the type locality which is within the southern Arabian upwelling region.

Remarks There is considerable scope for debate on the generic placement of this species. Should the obsolete divaricate sculpture indicate affinity with the Divaricellinae then the internal ligament would lead to *Lucinella* the only described member of the Divaricellinae with an internal ligament. There are only two species described belonging to the genus *Lucinella*: *L. divaricata* [Eastern Atlantic–Mediterranean] and *L. liratula* (Sow., 1889) [Cape Province, South Africa]. In both these species the sculpture extends across the median part of the shell, but unlike typical divaricellas these lines are only

slightly oblique.

Without the remnants of the divaricate sculpture all the other characters of the Oman material strongly suggest affinity with *Loripes*. Such is the similarity that we examined all lucines with an internal ligament but failed to find any with a similar sculpture. *Pillucina* has obsolete oblique lateral ribs, *Wallucina* an obsolete radial sculpture and *Microloripes* has strong marginal crenulations. No trace of non-concentric sculpture was found on any *Loripes* species and specifically not on the Indian Ocean *L. clausus*. At this time we have chosen to relegate the significance of the sculpture and choose *Loripes* as the appropriate genus. This decision however challenges the inferred apomorphic nature of a divaricate sculpture defining all members of the Divaricellinae.

#### UNCERTAIN GALEOMATOIDEA

Genus *Sagamikellia* Kuroda & Habe, 1971 Type species *Sagamikellia gibbosa* Kuroda & Habe, 1971

Sagamikellia khoroica n. sp. Figs 4–6

Axinopsida sp. Oliver in Dance (ed.) 1995: 237, Fig. 1035.

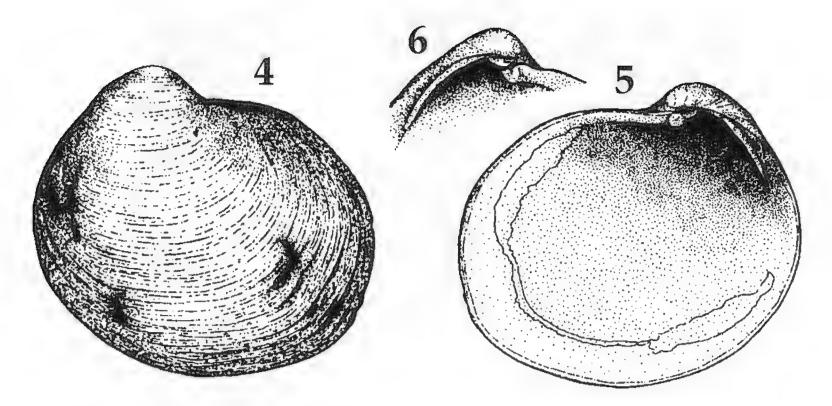
Holotype A single rv, Bandar Khayran, Ras al Hadd, Muscat, Oman. 23°31'N 58°43.5'E, xi.1992, leg. H.C.G. Chesney, NMW.Z. 1993.061.1715.

*Paratypes* A single lv as Holotype, NMW.Z. 1993.061.1714. 4LV +4RV as Holotype, NMW.Z. 1993.061.1716.

Other material examined 8v as Holotype, NMW.Z 1993.061.0419. 1rv, Grand Mosque Beach, Juffair, Bahrein, 26°N 51°E, from dredge spoil on beach, 4.xi.1992, leg. S. Green, NMW.Z 1993.061.0420.

Type locality Bandar Khayran, Ras al Hadd, Muscat, Oman.

Description Shell to 7mm, rather thin. Approximately spherical, obliquely subcircular generally inequilateral and extended anteriorly. Variability marked from equal height to length to longer than high. Anterior dorsal margin short but almost flat, posterior dorsal margin sloping steeply immediately from umbo, other margins rounded. Beaks markedly prosogyre with a distinct lunule area but no demarcation, escutcheon lacking.



Figs 4–6 Sagamikellia khoroica n. sp. Figs 4–5 Holotype, length = 6.8mm Fig. 6 hinge of left valve

Sculpture weak, of closely spaced irregularly developed concentric lines and weak ridges, often irregularly dented. Periostracum not observed but presumed to be thin. Hinge teeth of a single pseudo-cardinal peg in the RV, slotting into an ill-defined socket bounded by an anterior peg and a sub-umbonal tubercle. Ligament internal set on a long curving resilium. Adductor scars large and subequal, anterior scar not diverging from pallial line and lying in a normal anterior position; posterior scar lying in a posterior ventral position well below hinge margin. Pallial line entire. Inner margin smooth. Shell white.

#### Measurements (mm)

	Length	Height	Tumidity- (Single valve)	Valve
Holotype	6.8	6.7	2.8	RV
Paratype	6.6	6.8	2.8	LV
Paratype	4.0	4.3	1.5	RV
Paratype	4.1	4.5	1.3	RV
Paratype	4.3	4.2	1.6	RV
Paratype	5.5	6.1	2.2	RV
Paratype	5.4	6.2	2.1	LV
Paratype	5.1	5.3	2.0	LV
Paratype	5.1	5.3	1.9	LV
Paratype	5.7	6.2	2.0	LV

Derivation of name khoroica from the Arabic khor an inlet often associated with the mouth of a wadi and typical of the environment inhabited by this species as indicated by the suffix oica Gr., meaning home.

Distribution Known only from the Gulf of Oman near Muscat and the Arabian Gulf at Bahrain but probably is widely distributed through the northern Arabian Sea.

Remarks Kuroda & Habe (1971) described *S. gibbosa* from two valves collected from 60m. depth in Sagami Bay, Japan. Consequently there is very little material for comparative purposes and the range of variation is not known. The Arabian material is more numerous and differs in having no widely spaced lamellated growth lines but dense concentric often irregular simple lines. The Arabian material was found in intertidal mangrove front sediments and it is felt that this is not distant from its true habitat. There

are no records of this species from sites between Arabia and Japan rendering assessment of geographic gradients impossible. Given the differences in shell sculpture, habitat and the disparate geographic locations we are confident in giving the Arabian material sepa-

rate species status.

The supra-generic affinities of Sagamikellia are uncertain as there are no anatomical data to substantiate interpretations made on the shell. Oliver (1996) used the genus Axinopsida because of the overall similarity of the shell to the Thyasiridae and the presence of a cardinal protuberance. Kuroda & Habe (1971) give no explanation for their inferred affinities with the Kelliidae but of all galeommatid genera there is superficial similarity to Axinodon in the Montacutidae. Until living specimens are obtained we cannot resolve the affinities of Sagamikellia.

> Aenictomya n. gen. Type species ?Corbula mirabilis Lynge, 1909

Aenictomya mirabilis (Lynge, 1909) Figs 7–9

Corbula mirabilis Lynge 1909: "Corbula mirabilis" Lynge 1909. Oliver in Dance (ed.) 1995: 246, Fig. 1092.

In 1909 Hermann Lynge described a single valve as ?Corbula mirabilis from material collected by the Danish expedition to Siam (Thailand). His generic placement was provisional despite the very characteristic nature of the shell. To our knowledge no other shells have been collected and the systematic position has never been investigated. Recently samples of shells collected off Seeb near Muscat (Oman) for Don Bosch contained a single valve of ?Corbula mirabilis. The samples contained many thousands of shells but despite searching no others have been found.

In such situations where material is extremely rare it is often unsatisfactory to create new taxa. However when the material is so distinctive it is better to bring it to the attention of other workers rather than let the problem remain hidden for another 85 years. Lynge was uncertain of the orientation of his valve and his description, especially of the

hinge, we feel, warrants reinterpretation.

Holotype 1rv, North of Koh Kut, Gulf of Siam, 10 fathoms in mud. coll. T. Mortensen, Danish Expedition to Siam 1899-1900, ZMC.

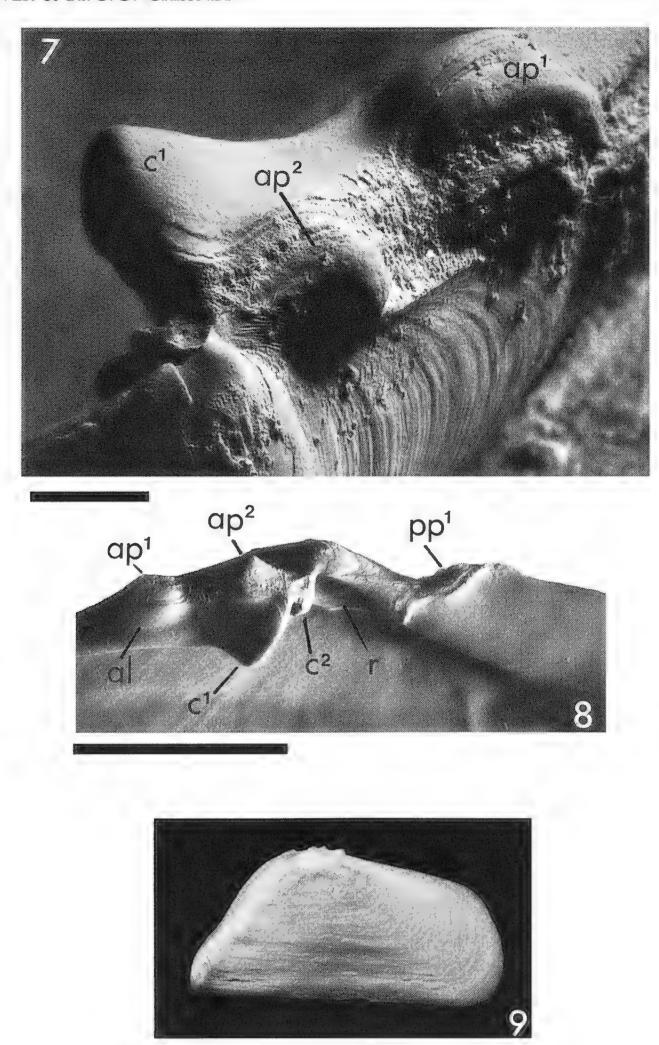
Other material 1rv, Off Seeb, N. of Muscat, Oman, 50–100ft, coll. Khamees Khalfan/D. T. Bosch, xi.1991, NMW.Z 1993.061.1506...

Measurements (mm)

	Length	Height	Tumidity	Posterior Length
			(Single valve)	
Holotype	11.0	5.5	1.0	4.2
Oman	12.0	5.8	1.1	4.4

Definition of genus and redescription of type species

Right valve only Strongly compressed, almost flat. Inequilateral, beaks towards the posterior, PL: AL = 1:2.7. Outline rhomboidal; posterior acute with a slight flexure, posterior margin steeply angled from close to the beak and more or less straight; ante-



**Figs 7–9** *Aenictomya mirabilis* Lynge, 1909 (NMW.Z. 1993.061.1506) **Fig. 7** Anterior dorsal hinge plate viewed from above SEM x100 **Fig. 8** Internal view of entire hinge plate SEM x35 **Fig.** 9 External view of valve, length = 12mm

rior rounded, anterior dorsal margin long, sloping gently to beak; ventral margin more or less straight. Posterior with a sharp carina running very close to posterior margin. Sculpture of weak growth lines with a few weak ridges developing ventrally; anterior with weak pustulose ornamentation. Prodissoconch large, smooth and without a cap. Ligament on a weakly defined internal resilium lying posterior to the beak and extending as far as the posterior marginal protuberance. Hinge teeth a combination of true teeth and marginal extensions of the valve; hinge dominated by a large inwardly projecting peg-like cardina, anterior to the ligament, beneath it is an accompanying ridge and groove; Other teeth projecting dorsally, consisting of two anterior and one posterior protuberances. Adductors scars of roughly equal size. Pallial line entire, relatively broad adjacent to the adductor scars.

Origins of hinge teeth The dorsally projecting teeth (Figs 7–8) are an unusual feature and should provide key indications to systematic affinities. On close examination (Fig. 7) some teeth show jointing lines indicating that they are not derived from the hinge plate. The large forward projecting tooth  $(c^1)$  and the ridge  $(c^2)$  beneath it are part of the hinge plate and are cardinal in position. The ridge beneath may represent an overgrown cardinal. The anterior most dorsal protuberance consists of a thickening of the hinge plate (al), adhering to it an extension of the dorsal margin  $(ap^1)$ . This tooth then is, in part, an anterior lateral. The inner anterior dorsal projection  $(ap^2)$  consists almost entirely of an extension of the dorsal margin. The posterior dorsal protuberance  $(pp^1)$  is entirely an extension of the margin. The true dentition is therefore of a single cardinal and a single anterior lateral with the possibility of a second cardinal overgrown by the first.

Systematic affinities Lynge (1909) admitted that he could not place this shell in any genus but suggested *Corbula*. He assumed that the ligament lay in the groove below the large cardinal and did not observe the weak posterior resilium, neither did he recognise the anterior protuberance as a lateral tooth. Given the nature of the hinge and ligament,

placement in the Corbulidae is not satisfactory.

The combination of the entire pallial line and hinge are more suggestive of the Galeommatoidea and Sportellidae. The carinate form is more frequently found in the Sportellidae as is the pustulose sculpture, both of which are present in *Basterotia*. *Basterotia*, as with other Sportellidae, has a primarily external ligament with an associated nymph quite unlike *Aenictomya*. The extensive internal ligament is similar to that found in some Kelliidae and Montacutidae. It is also in the Galeommatoidea that dorsally projecting teeth appear, such as in *Galeomma* and *Ephippodonta*. Dorsal projections are often associated with those forms in which the valves open very widely, where they operate to prevent rotation of the valves. Such forms however tend to be thin equilateral shells.

Projecting teeth are also found in the Mesodesmatidae. The genus *Monterosatus* Beu, 1976, formerly *Nesis* Monterosato, 1875 has a single projecting flange situated anteriorly. Like *Aenictomya* it has an internal resilium and no pallial sinus but has no posterior tubercles and is roundly elliptical in form with no carination. Whether *Monterosatus* is a Mesodesmatid remains open to question.

The affinities of *Aenictomya*, based on shell characters alone are probably with the galeommatids but more, preferably living material is needed to verify this position.

#### **CARDITOIDEA**

The majority of recorded species of Carditoidea from Arabian shores are the larger members of the Carditidae (eg. *Cardita*, *Beguina*, *Cardites*) and very few smaller species, especially those in the Condylocardidae, are known from this region. Only *Carditella concinna* Melvill, *Cuna majeeda* Biggs and *Cuna coxi* Eames & Wilkins are described, the latter from Karachi and the former from the Trucial Coast of the Gulf. Among collections from Bahrain (Leg. Stephen Green), Muscat (Leg. Don. Bosch) and Masirah (Leg. Martyn Day) are a few specimens of small carditids, two of which are apparently undescribed. This section describes these forms and reviews the systematics of the smaller carditids from the Arabian region.

#### CARDITELLINAE

Genus *Carditopsis* E.A. Smith 1881 Type species *Cardita flabellum* Reeve 1843

#### Carditopsis majeeda (Biggs, 1973) Figs 10, 12, 15–16

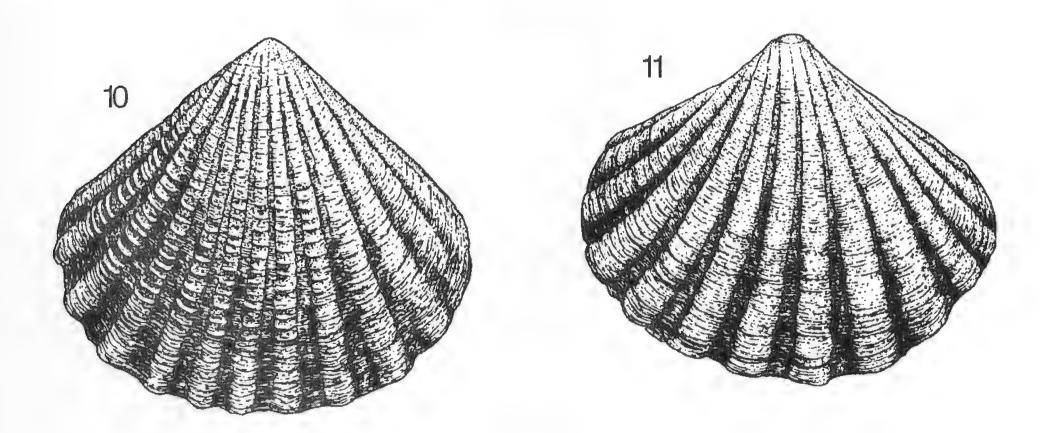
Cuna majeeda Biggs, 1973: 387, pl. 6, Fig. 5-8, Text Fig. 7.

Material Examined 2sh, Bahrain, from shell sand, 26°N 51°E, coll. S. Green, 12.ii.1993 NMW.Z. 1993.061.0922. 5v, Oman, Muscat, dredged from 20-40m. off Seeb in muddy shell gravel, 23°41′N 58°11′E, coll. D. Bosch/Khamees NMW.Z. 1993.061.1512. 6v, Bubiyan Island, Kuwait, 29°N 48°E, ex Biggs Coll., Leg. K. Smythe, 1972.

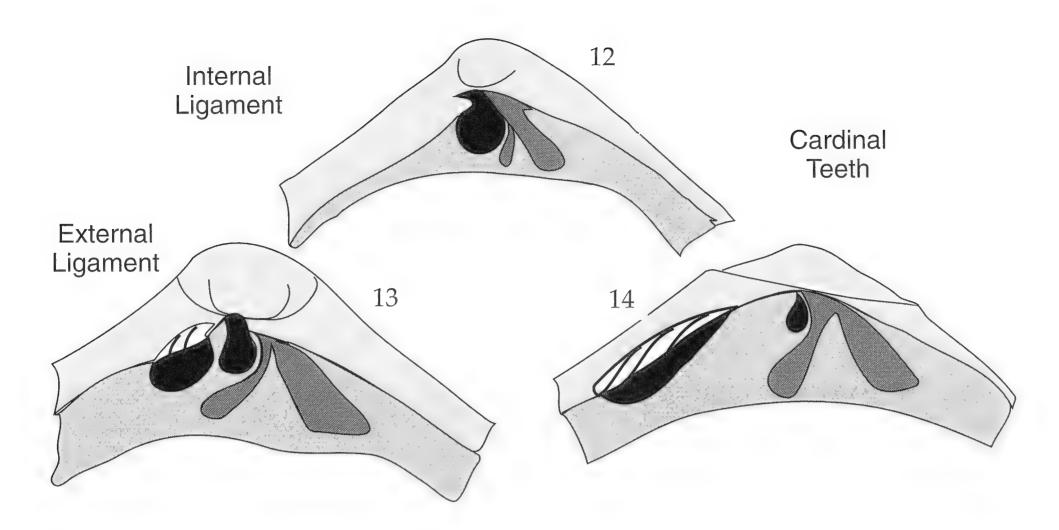
Description To 2mm. Equivalve. Beaks almost central. Outline trigonal with steeply sloping dorsal margins, posterior margin slightly longer than anterior. Escutcheon large and flat, lunule area similar but smaller. Prodissoconch prominent but rounded. Sculpture of 10–11 radial ribs with interspaces of similar size, posterior ribs slightly scabrous. Ligament wholly internal set on a resilium beneath the beaks. Hinge: RV with two narrow cardinal teeth in front of the beak, the posterior tooth greatly eroded by encroaching resilium, anterior lateral in a marginal position, posterior lateral with a corresponding socket; LV with a single triangular cardinal, posterior lateral marginal, anterior lateral with a socket. Inner margin crenulate. Colour amber to brown.

Habitat Although very few living examples of *C. majeeda* have ever been taken records suggest that it inhabits sand and shell sands in shallow water, but is not intertidal.

Remarks Cuna coxii Eames & Wilkins 1957 is similar to C. majeeda but is oblique in outline with 8–10 strong ribs with prominent cross ridges. Biggs (1973) placed his new species in the genus Cuna but this is not supported here. The Cuniinae have narrowly triangular shells with a spondyliform hinge and long laterals; the sculpture is weak. Carditopsis is not so narrow, the hinge is not spondyliform and has a strong radial sculpture. Comparison of C. majeeda with Carditopsis flabellum and Carditopsis smithi show it to be very close to these American species. Cuna coxii should also be placed in Carditopsis. The affinities of Carditopsis are discussed below.



**Fig. 10** *Carditopsis majeeda* (Biggs, 1973), (NMW.Z. 1993.061.922), Bahrain, length = 2mm **Fig. 11** *Carditella tridacnula* n. sp. (NMW.Z. 1993.061.1595) Holotype, Off Ras abu Rasas, Masirah, length = 2.9mm



Figs 12–14 Diagrams of carditid hinges (left valve): Fig. 12 Carditopsis majeeda. Fig. 13 Carditella tridacnula. Fig. 14 Carditella semen.

Genus *Carditella* E. A. Smith 1881 Type species *Carditella pallida* Dall 1903

Carditella tridacnula n. sp. Figs 11, 13, 17–18

Carditella n. sp. Oliver in Dance (ed.) 1995: 242, Fig. 1065.

Holotype 1 complete sh, off Ras abu Rasas, Masirah, 20°10'N 58°38'E, 6m depth, 12.ii.1993, NMW.Z. 1993.061.1595.

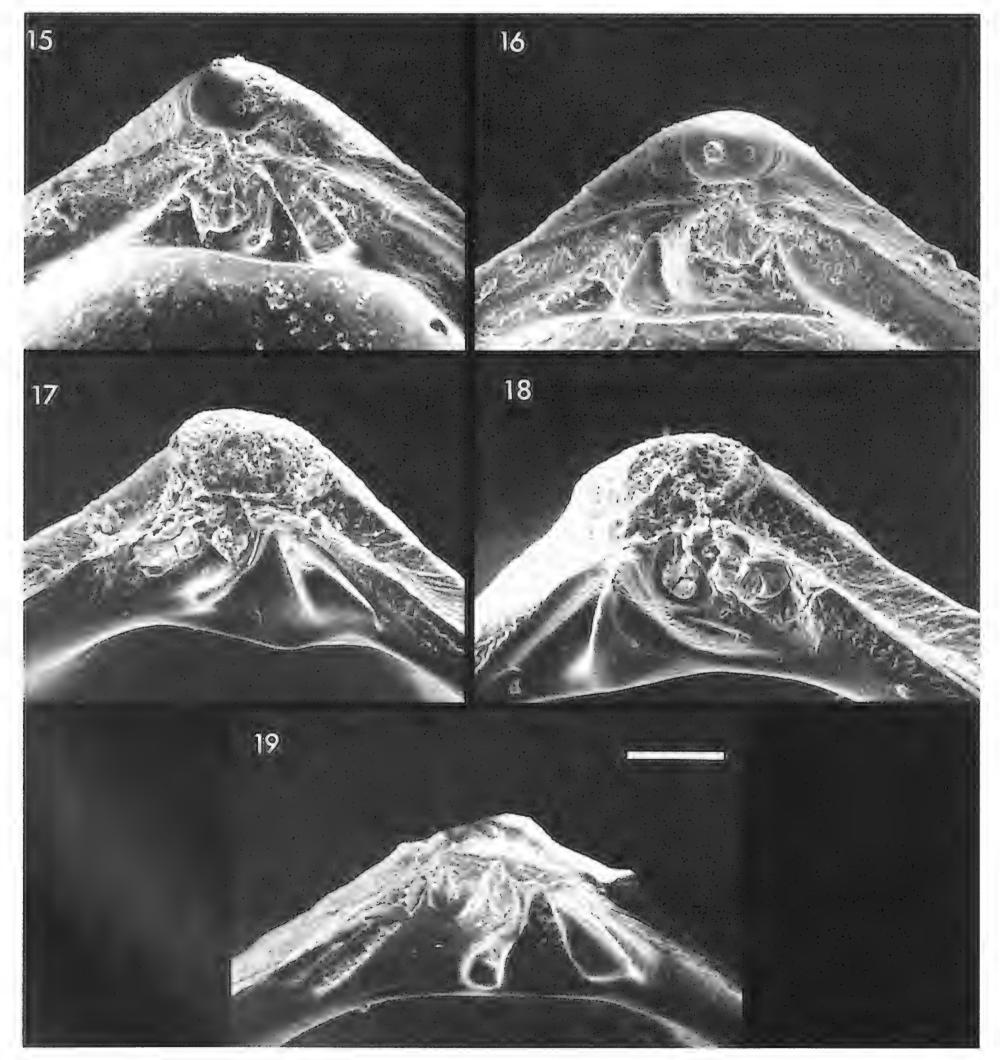
Paratypes Masirah 4v as Holotype, NMW.Z. 1993.061.1713. 1 complete sh, Urf, strandline, 20°12'N 58°42'E, 10.ii.1993, NMW.Z. 1993.061.1597. 2sh + 12v, Hidden Reef, 6km south of British Eastern Relay Station, 20°38'N 58°54'E, 10m depth in sand pocket, 12.vi.1993, NMW.Z. 1993.061.1711. All material collected by Martyn Day.

Description To 3mm. Equivalve. Tumid. Beaks a little to the anterior. Outline transversely oval with trigonal umbos; sloping dorsal margins distinct, posterior margin slightly longer than anterior. Escutcheon large and slightly excavated, lunule area similar but smaller. Prodissoconch prominent pitted and capped. Sculpture of 9–10 large rounded radial ribs usually with a smaller rib adjacent to dorsal margins, interspaces narrower than ribs; rib ornament weak of irregular fine concentric line only. Ligament in two parts; a small sunken external band barely visible from the outside and a small internal resilium beneath the beaks. Hinge: RV with two narrow cardinal teeth in front of the beak, anterior lateral in a marginal position, posterior lateral with a corresponding socket; LV with a single triangular cardinal, posterior lateral marginal, anterior lateral with a socket Inner margin crenulate. Colour white with amber patches especially over the posterior area.

Measurements (mm)

	Length	Height	Tumidity	Valve
Holotype	2.9	2.4	1.6	Both
Paratype	3.3	2.5	0.9	LV
Paratype	3.0	2.4	0.9	LV
Paratype	3.0	2.5	0.9	LV
Paratype	2.8	2.4	0.8	LV
Paratype	3.2	2.6	1.0	LV
Paratype	3.0	2.4	1.8	Both
Paratype	2.1	1.7	1.0	Both

Habitat Living examples have never been collected but one might expect this small species to live in clean shell sand or gravel.



15 - 19Scanning electron micrographs of carditid hinges Figs 15(LV)-16(RV) Carditopsismajeeda. Figs 17(LV)-18(RV) Carditella tridacnula. Fig. 19(LV) Carditella semen. Scale bar  $=100\mu m$ 

Derivation of name tridacnula L. from Tridacna with the diminutive suffix pertaining to the similarity to a minute giant clam.

Discussion The most complex aspect of this work has been to find the correct generic and suprageneric placing for the species described, especially *C. tridacnula*. Chavan (1969) places *Carditella* in the Carditidae on the presence of the external ligament and *Carditopsis* in the Condylocardiidae because of the wholly internal ligament. Although Chavan mentions a minute resilium in *Carditella* its significance is not discussed. Far from placing *Carditella* and *Carditopsis* in separate families, Dall (1903), regarded them as subgenera of *Erycinella*. Lamy (1921) did not follow this but did place them together in the Condylocardiidae. Figures 14 & 19 show the hinge of a typical *Carditella* (*C. semen, Reeve*) with a large external ligament and a minute internal resilium. *Carditopsis majeeda* is typical of the genus in having a wholly internal ligament (Figs 12, 15–16). *Carditella tridacnula* is intermediate in having both a significant resilium along with a small but sunken external element (Fig. 13, 17–18). In all the general form of the shell and hinge details correspond. Along with the enlargement of the resilium there is a corresponding erosion of the RV posterior cardinal. Given this evidence it is suggested that *Carditella* and *Carditopsis* are part of a single lineage.

Carditopsis could be regarded as a possible precursor for the Condylocardiinae and Cuniinae as these subfamilies could represent the consequences of further reduction in size and internalisation of the ligament. A consequence of the reduced cardinal dentition is the elongation of the lateral teeth. If this was substantiated then Carditella along

with Carditopsis would be correctly placed in the Condylocardiidae.

An alternative option is to consider that the internalisation of the ligament occurred in more than one lineage and that *Carditella* and *Carditopsis* are not part of the Condylocardiidae but are a branch of the Carditidae. The latter stance could lead to the acceptance of the subfamily Carditellinae as proposed by Iredale & McMichael (1962) and used later by Habe (1977), Bernard (1983) and Bernard, Cai & Morton (1993).

#### VENERICARDINAE

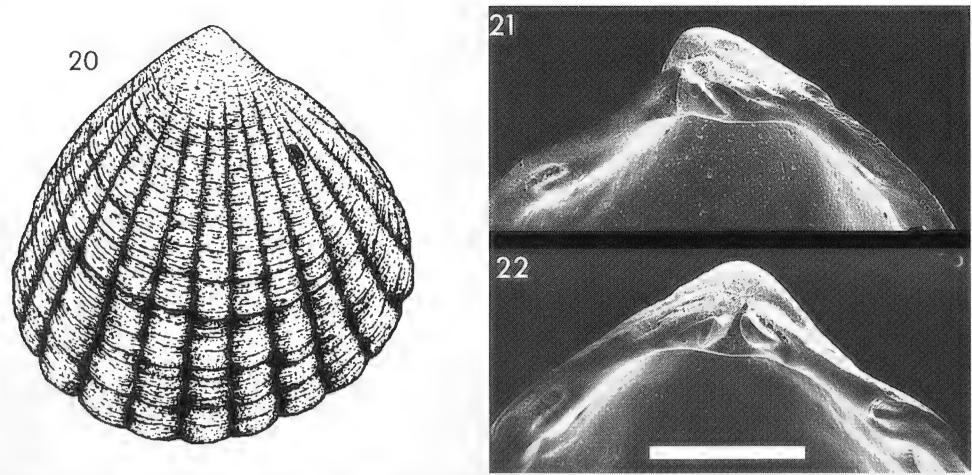
Genus Carditellopsis Iredale 1936 Type species Carditella elegantula Tate & May 1901

Carditellopsis martyni n. sp. Figs 20–22

Holotype 1v, Off Ras abu Rasas, Masirah, 20°10'N 58°38'E, 6m depth, 12.ii.1993, NMW.Z 1993.061.1599.

Paratypes 8v, as Holotype, NMW.Z. 1993.061.1712.

Other material examined Oman, Masirah 1v, Island Reef, 20°42.5'N 58°52.5'E, 10.5m depth in sand over rock, 21.iii.1993, NMW.Z. 1993.061.1557. 1v, Hidden Reef, 6km south of British Eastern Relay Station, 20°38'N 58°54'E, 10m depth in sand pocket, 12.vi.1993, NMW.Z. 1993.061.1558. 2v, West Horn Reef, 20°42'N 58°53'E, 9m depth, 7.ix.1993, NMW.Z. 1993.061.1561. 1v, Ras Qudufah, 20°41'N 58°55'E, strandline, 10.ii.1993, NMW.Z. 1993.061.1593. 1v, Urf, 20°12'N 58°42'E, strandline, 10.ii.1993, NMW.Z. 1993.061.1598. All material collected by Martyn Day.



**Fig. 20** *Carditellopsis. martyni* n. sp. (NMW.Z 1993.061.1599), Holotype, Off Ras abu Rasas, Masirah, length = 3.5mm

Figs 21–22 Carditellopsis. martyni n. sp. hinge plate, RV and LV respectively. SEM Scale bar = 1mm

#### Type locality Ras abu Rasas, Masirah, Oman.

Description Shell to 3.7mm. Solid. Subcircular with distinct attenuate umbo, slightly inequilateral with anterior slightly expanded. Posterior slope more steep than anterior, both rounded. Escutcheon at lunule areas present but neither markedly or sunken delineated. Sculpture of about 15 (13–16) prominent but low, rounded radial ribs, all closely spaced; each weakly sculptured with cross bars and incremental lines. Hinge in left valve with 2 large cardinals, a small posterior socketed lateral and a short marginal anterior lateral; left valve with a large single cardinal and a single socketed anterior lateral and a marginal posterior lateral. Ligament in a shallow external resilium. Adductor scars large subequal, inner margin crenulate. Colour white through pinkish to rust brown.

#### Measurements (mm)

	Length	Height	Tumidity	Valve
Holotype	3.4	3.2	0.9	LV
Paratype	2.8	2.4		LV
Paratype	3.0	2.7		RV
Paratype	3.4	3.2		LV
Paratype	3.5	3.2		RV
Paratype	3.7	3.3		LV
Paratype	3.3	3.1		LV
Paratype	3.6	2.3		LV

Habitat Living examples have never been found but one might expect this small species to inhabit clean shell sand or gravel.

Derivation of name martyni named for Martyn Day who collected many of the specimens from Masirah used in this paper.

Remarks Due to the inconsistent use of generic names among the smaller Carditidae, we examined a wide variety of taxa variously assigned to Carditella, Cyclocardia and Cardita. Carditella concinna Melvill 1918 from Karachi is the only related species described from the Arabian Sea. It is a minute species, with strongly elevated ribs

bearing prominent cross bars and is not comparable with *C. martyni*.

Of the species examined described from the Indian Ocean, the closest resemblances were to *Carditella subradiata* and *C. similis* both described by Thiele & Jaeckel (1931). In both, however, the rib count is 20. *Carditella valdiviae* also of Thiele & Jaeckel (1931) is oblique in form and resembles the young of *C. laticosta* Smith. Other small, South African species of carditids include the superficially similar *Cyclocardia elata* Sowerby but that species has a deeply excavated lunule and is not congeneric with *C. martyni*. Broadening the scope for closely related species: *Carditella pusilla* Lynge 1907 from Siam has 18 ribs with deep interspaces all with closely packed transverse ridges. *Carditella infans* Smith 1885 from New Guinea has only 13 ribs and a heart shaped lunule.

#### CARDIOIDEA

#### **CARDIIDAE**

Genus **Lyrocardium** Meek 1876 Type species *Cardium lyratum* Sowerby, 1841

*Lyrocardium anaxium* n. sp. Figs 23–24

Cardium lyratum Sow. Nardini S. 1937: 254, pl.9, Figs3a-b. Laevicardium (Discors) lyratum Sow. Fischer-Piette 1977: 9–11. in part. Nemocardium aurantiacum Adams & Reeve. Bosch & Bosch 1982: 172. Lyrocardium n. sp. Oliver in Dance (ed.) 1995: 245, Fig. 1086.

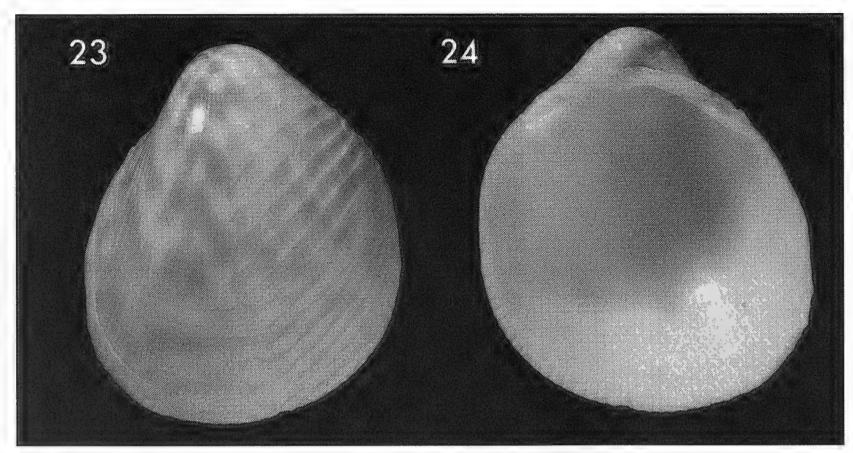
*Holotype* 1 specimen from strandline between Maaghla and Haql, east coast of Masirah, Oman, coll. Martyn Day, 10.i.1994, NMW.Z.1995.002.429. Dimensions of holotype L = 41.2mm: H = 48.1mm: Tumidity both valves = 36.7mm

Paratypes 3v, Masirah, coll. H. Henseler, NMW.Z.1993.061.1513.

Other material examined Red Sea, Egypt 1v, Scadwan Id., NE Hurghada, 3.viii.1992, coll E. Neubert. Many v, Bay of Safaga, coll. M Zuschin. 1sh, Bay of Safaga, 15–20m, 8.iv.1997, coll P. G. Oliver, NMW.Z. 1997.021.015. Oman, Masirah Many v, coll. H. Henseler. Many v, 1993–1994, coll. M. Day. Many v, Umq, coll. Don. Bosch. Yemen 1sh, Aden, coll Dinshau, BM(NH) 1902.12.30.602.

Type locality East coast of Masirah, Oman, Arabian Sea.

Description Shell to 52mm in height. Solid but not thick, exterior shiny. Equivalve. More or less equilateral. Outline obliquely ovate in small shells, becoming more symmetrical with age, higher than long; umbos prominent; posterior margin straightening, anterior margin more rounded; anterior dorsal slope short and steep, posterior dorsal slope short and slightly concave. Sculpture of low oblique ridges anteriorly, these increasing in number to 20 in the largest examples; oblique ridges fade about the mid line and are replaced by numerous fine radial ridges. These ridges are also present beneath the anterior sculpture and number from 42–47. The radial element is less



**Figs 23–24** *Lyrocardium anaxium* n. sp. (NMW.Z.1995.002.429), Holotype, East coast of Masirah, Oman, length = 41.2mm

pronounced in small shells. Hinge with small teeth; 2 cardinals in each valve but the dorsal most becoming obsolete; RV with paired anterior and single posterior submarginal laterals; LV with single anterior submarginal lateral and single marginal posterior lateral. Inner margin fine crenulate except at margins opposite adductor scars. Shell colour distinctive, white with dense chestnut brown patches on the umbos, these thinning ventrally; posterior area suffused rose pink: internally white suffused pink in umbonal cavity.

#### Measurements (mm)

Length	Height	Tumidity (sv)	Oblique Ridges	Length	Height	Tumidity (sv)	Oblique Ridges
43.9	51.4	18.3	17	27.1	30.2	11.3	$1\overset{\circ}{0}$
41.9	49.3	18.1	20	26.5	29.3	10.6	12
41.5	50.1	17.8	19	23.2	24.6	8.6	8
40.5	44.8	16.5	15	21.7	23.8	8.6	8
37.2	39.9	14.3	12	20.7	22.2	8	7
35.9	40.0	14.3	15	20.5	20.3	7.2	6
28.1	31.1	10.8	11	20.4	20.5	7.5	9
28.0	31.1	11.2	9	20.2	21.2	7.2	6
27.8	29.8	10.2	10	19.4	20.2	7	7
27.3	29.8	10.7	9	16.5	17.1	6	5

*Derivation of name* anaxium from the Greek **anaxios** meaning royal and pertaining to the superior size and colouration of the species.

Distribution Commonly at Masirah but sporadically from Socotra, Aden and northern Red Sea.

Remarks We cannot agree with Fischer-Piette (1977) that Lyrocardium lyratum and L. aurantiacum are synonymus and concur with Wilson & Stevenson (1977) that the latter species never has the wine red periostracum, has a smooth posterior and attains a smaller size. L. anaxium differs from L. lyratum in having a highly coloured shell, lacking the wine red periostracum, and having a weaker sculpture overall but especially on the posterior area. From L. aurantiacum it differs in having pink colouration over the posterior

rior area, in developing radial riblets on the posterior, having less dense oblique anterior ridges and reaching a much larger size. In many ways *L. anaxium* is more similar to the west African *L. aeolicum*.

Lyrocardium anaxium has never been found living on Masirah and it has been assumed to be a deep water species whose shells are washed ashore after storms. Indeed the largest lot we have was collected by Mr. Harry Henseler after the 1976 hurricane which hit Masirah. Elsewhere records are infrequent and sporadic with confirmable occurrences at Socotra, Aden and the northern Red Sea. Lyrocardium anaxium does not overlap in range with either L.lyratum and L. aurantiacum.

#### Genus **Trachycardium** Morch, 1853 Type species *Cardium isocardia* Linnaeus, 1758

The generic subdivisions of the Trachycardiinae have always been debated and there is little consistency in their use (Wilson & Stevenson, 1977; Fischer-Piette, 1977; Voskuil & Onverwagt, 1991). Given this inconsistency we use *Trachycardium* in its broadest sense but note that of the species discussed here *T. rhegminum* is closest to *T. reeveanum* the type species of *Regozara*. *Regozara* may be considered to be conspecific with the American *Acrosterigma*. The name *Acrosterigma* has received general usage in recent years (Wilson & Stevenson, 1977; Vidal, 1993) *Trachycardium impolitum* does not fall so easily into any of the nominal subgenera and may warrant some generic rank as hinted by Wilson & Stevenson (1977) for the *T. arenicolum* group in general.

### *Trachycardium impolitum dilmunensis* n. subsp. Figs 25–26, 29–32

Trachycardium lacunosum (Reeve). Biggs 1973: 395 (in part). Trachycardium maculosum (Wood). Biggs 1973: 395 (in part). Acrosterigma n. sp. (a) Oliver in Dance (ed.) 1995: 246, Fig. 1089

Holotype Live collected specimen, BM(NH) 1994.100 Persian Gulf, Trucial Coast Stn. PG/Gl89/62 coll. Biggs.

Paratypes 2 sh, Abu Dhabi, Persian Gulf, leg. G. Evans 1962, coll Biggs, BM(NH). 2sh figured in Arabian Seashells NMW.Z.1993.061.1360.

Other material examined >250v. from dredge spoil, Grand Mosque Beach, Juffair, Bahrain, coll. S. Green 1991–1993, NMW.Z.1993.061. 1sh + 21v, Persian Gulf 26°35'N, 54°E, dredged from 35m, Calypso Voyage 1954, MNHP.

Type locality Persian Gulf, Trucial Coast Stn.

Description Shell to 45 mm in height. Solid but not heavy. Equivalve. More or less equilateral, very slightly oblique. Narrowly ovate, height greater than length (H/L range 1.15–1.29), umbos distinctly pointed; posterior dorsal margin long and sloping immediately from beaks; anterior dorsal margin short and angled against the straightening anterior margin. Sculpture of 33–41 (mean = 36) low, narrow radial ribs with a generally smooth appearance but having a wavy sculpture developing into weak cross bars towards the anterior margin; median ribs asymmetric, posterior edge much steeper than anterior; 8–9 posterior ribs have a row of tubercular shaped spines along their posterior edge which when worn have the appearance of a low ridge. Hinge line short and

strongly angled; both valves with paired cardinals, the upper anterior weak and merging with dorsal margin; LV with single laterals, RV with socketed laterals but posterior socket poorly developed. Inner margin deeply crenulate. External shell colour off-white to beige with irregular pink to purple blotches, covered by a thin beige periostracum in fresh valves. Internally white with blotches and bands of pink or purple colouration.

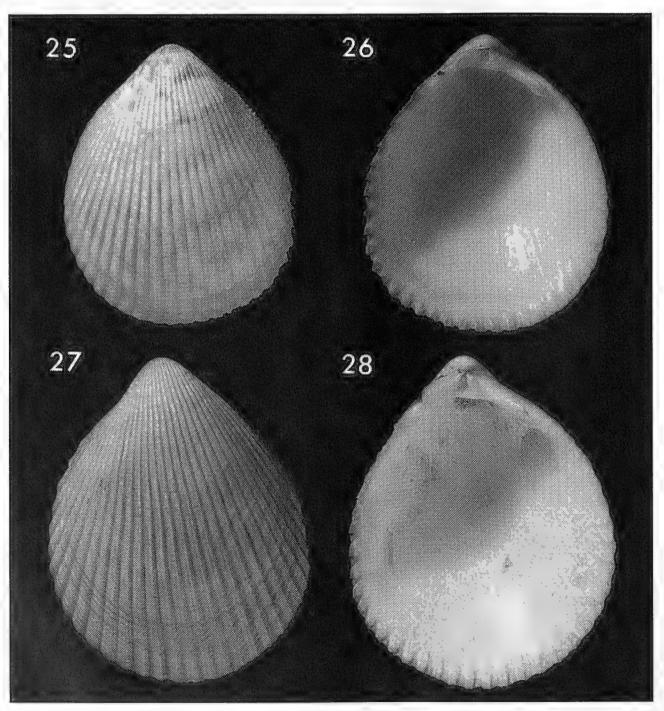
Measurements for T. impolitum dilmunensis

	Height	Length	B-PR	Rib No	Post Rib No	H/L	H/B-PR
Holotype Paratype	43.03 38.51	35.48 32.82	34.31 29.00	37 40	9 8	1.213 1.173	1.254 1.328
Paratype	25.89	21.96	19.53	37	9	1.179	1.326

All measurements used for morphometric comparison of *T. i. impolitum* and *T. i. dilmunensis* are available from the senior author.

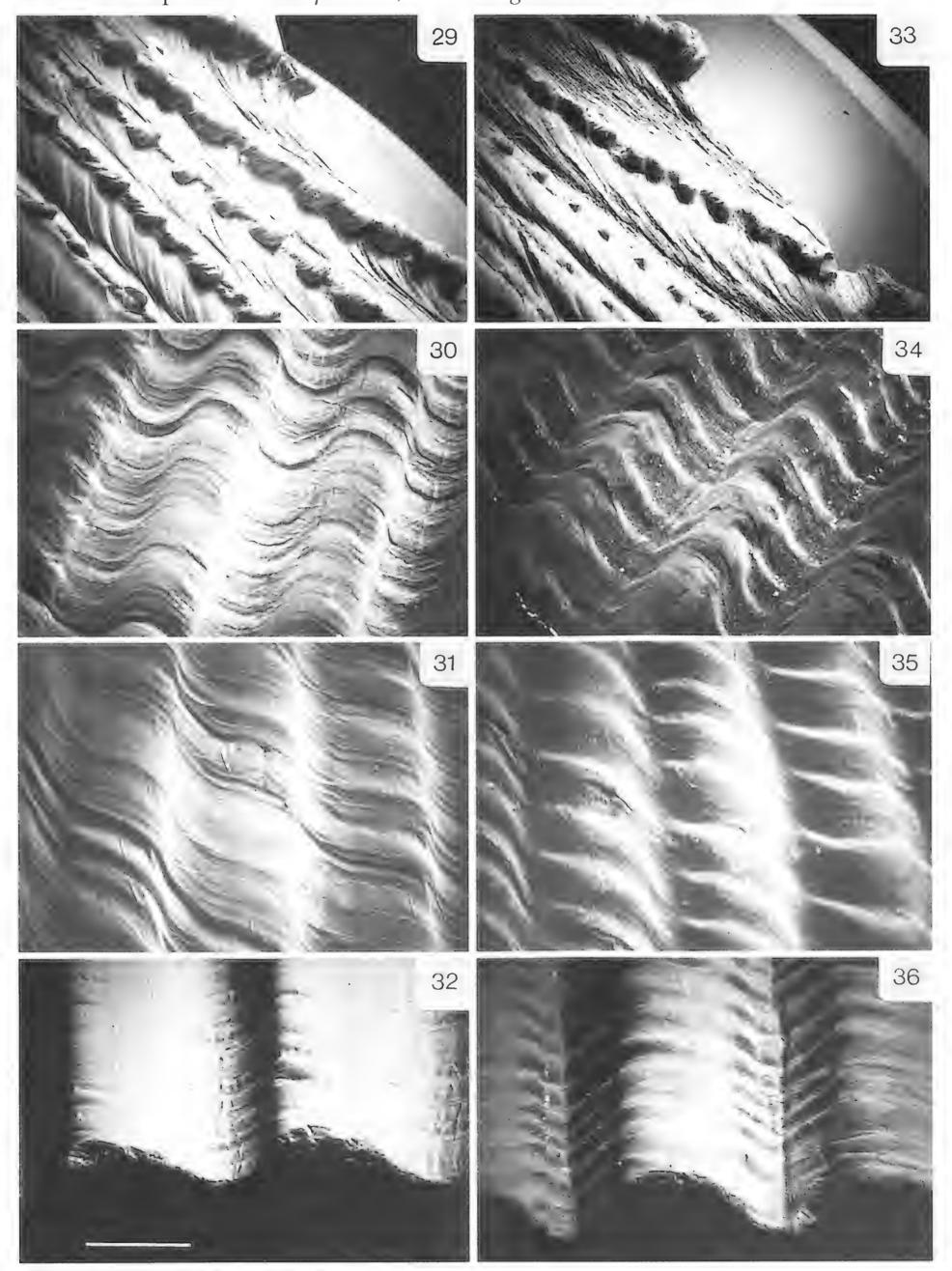
Derivation of name dilmunensis from Dilmun the ancient city believed to be situated close to Bahrain and ensis Latin suffix denoting place from where one originates.

*Distribution* This particular form of *T. impolitum* is known only from the north-western and south-eastern parts of the Persian Gulf.

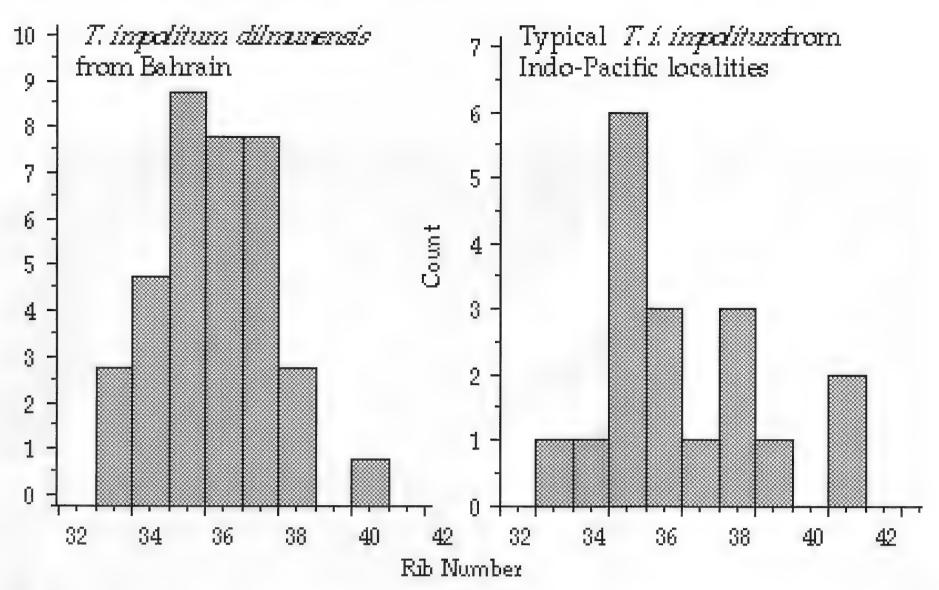


**Figs 25–26** *Trachycardium impolitum dilmunensis* n. subsp. (BM(NH) 1994.100), Holotype, Stn. PG/Gl89/62 coll. Biggs, Trucial Coast, United Arab Emirates, Arabian Gulf, height = 43mm **Figs 27–28** *Trachycardium impolitum* (Sowerby) (NMW. 1955.158), Singapore, height = 47mm

*Remarks* The shell form of the Gulf population clearly allies it to the group of species referred to as the *T. arenicolum* group by Wilson & Stevenson (1977), and includes *T. impolitum*, despite its absence in the above paper. Wilson & Stevenson (1977) introduced a further three species: *T. dampierense*, *T. vlamingi* and *T. rosemariense*.



**Figs 29–32** *Trachycardium impolitum dilmunensis* n. subsp. **Figs 33–36** *Trachycardium impolitum* Sowerby; **Figs 29** & **33** posterior spined ribs; **Figs 30** & **34** anterior ribs; **Figs 31** & **35** posterior non spined ribs; **Figs 32** & **36** median ribs All SEM Scale bar = 1mm



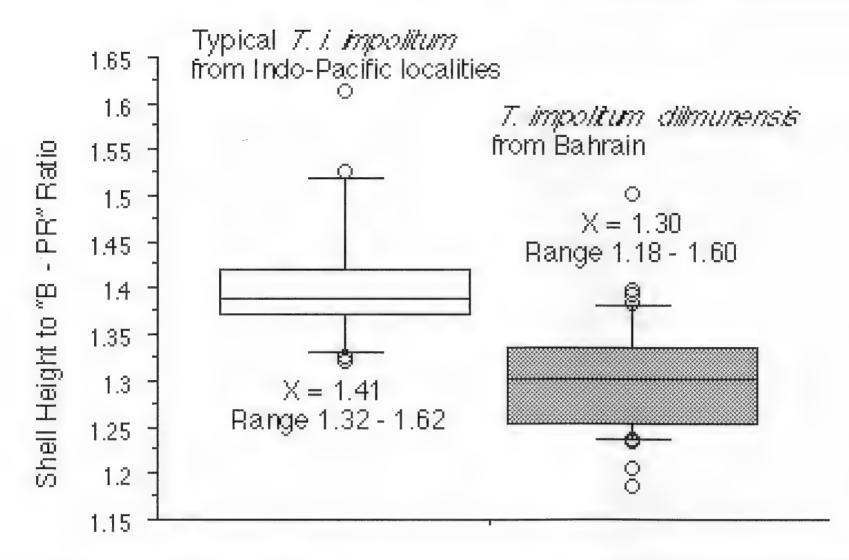
**Fig. 37** Bar charts showing rib number ranges for *Trachycardium impolitum impolitum and T. i. dilmunensis* 

Using type descriptions, *T. arenicolum*, *T. vlamingi* and *T. rosemariense* would be excluded from further consideration by having average rib counts of over forty. Consequently we have limited our comparison to *T. impolitum* proper and *T. dampierense*. Comparison of types strongly suggest that these two species are synonymous. However, we have also taken note of Vidal's (1993) "polytypic" concept illustrated by *T. elongatus* and from personal communication he suggested that all of the above nominal Australian species are synonymous with *T. impolitum*. Following this we included all such specimens present in NMW.Z and MNHN in our analysis. Rib number gave a trimodal histogram for the total *impolitum* complex suggesting that we could not accept the amalgamated complex as a single 'population'. This contrasts with the Gulf Rib Number histogram which gave a unimodal normal curve.

As it is beyond the scope of the materials at hand we cannot comment further on the cohesion of Vidal's impolitum complex. Comparison with typical impolitum (Figs 37–38, 33–36) reveals that in terms of rib number, posterior rib number and H/L ratio, that the Gulf population lies within the range of T. impolitum. Visual comparison, however, suggests some differences in the region of the posterior dorsal margin, subjectively best described as being more flattened in typical forms than in the Gulf form, and a more frequent tendency to develop a short, distinct, flattened posterior margin. In order to objectively assess this we measured the distance from beak to the end of the last toothed posterior rib (B-PR in tables) as compared to the height of the shell. This comparison is significant at 99% level and does indicate that the Gulf form is slightly different in outline. The overall sculpture of typical *impolitum* is stronger (compare Figures 30 to 36) except that the posterior rib tubercles are equally developed (compare Figures 29 and 33). The median rib shape of the Gulf form is asymmetric such that the apex is angulate and this contrasts with typical impolitum where the ribs are almost symmetric with a flattened apex (compare Figures 32 and 36). Colour, a character which is rarely reliable at the higher taxonomic levels, is consistently brighter in the Gulf form with much more extensive and stronger reddish maculations.

The problem posed is, are these differences indicative of local variability or a more





**Fig. 38** Box plots of the ranges of the ratio "Shell height to length from Beak to last spined rib (B-PR)" for *Trachycardium impolitum impolitum* and *T. i. dilmumensis*.

profound taxonomic level. Before considering this it should be noted that the Gulf form is to our knowledge unique to the Arabian Gulf and despite the large collecting efforts made for the production of Dance et al (1995) it has never been found in the Gulf of Oman. Unfortunately we have not been able to locate the material collected by Major Baker from Karachi cited as T. impolitum in Melvill & Standen (1907). Typical T. impolitum is known from Burma, Singapore, western Australia through to China and the western Pacific. The Gulf form, therefore, appears to be very isolated, but our knowledge of the western coast of the Indian sub-continent is scant. Environmental conditions in the Gulf are atypical of the truly tropical environments of the Indo-W. Pacific with high salinity and large temperature fluctuations. Oliver & Glover (1996) comment on the morphological differences of Gulf forms of venerids and one must accept the potential ecophenotypic variation of Gulf populations. It is also apparent that the Gulf of Oman and NW Indian parts of the Arabian Sea exhibit a higher degree of endemism and faunistic change as one moves north from Sri Lanka. There is, in general, a reduction in species considered typical of the Indo-West Pacific (pers. observation). Combining this with the current uncertainty of species differentiation in the *T. impolitum* group leads to the conclusion that at this stage it is appropriate to give subspecies status to the Gulf form. This Gulf form remains intriguing because of its geographic restriction and isolation, and clearly warrants further investigation.

## Trachycardium (Acrosterigma) rhegminum n. sp. Figs 37–40

Acrosterigma n. sp. (b) Oliver in Dance (ed.) 1995: 246, Fig. 1092.

*Holotype* 1 live spec. off Ras Madrakah, Masirah, 19°22'36"N 57°53'00'E, coll "John Murray" Expedition, Stn. 53, 13.5m depth, BM(NH).

Paratypes 1 spec., NMW.Z. 1994 and 3 spec., BM(NH), as Holotype.

Other material examined Masirah 43v, as type series, BM(NH). 15v, Storm beach oppo-

70

site the British Eastern Relay Station Camp, Ras Hilf, coll. Oliver & Chesney, xi.1992, NMW.Z. 1993.061.1348 & 1359. 1v, coll. Biggs, 1967, BM(NH).

Ras Madrakah, Masirah. Type locality

Description Shell to 60 mm in height. Solid rather heavy. Equivalve. More or less equilateral only very slightly oblique. Outline ovate higher than long (H/L ratio =  $1.21 \pm .04$ ). Anterior dorsal slope longer and steeper than posterior dorsal slope. Posterior margin straightening, anterior margin gently curved. Posterior area flatter than anterior almost sulcate in some. Lunule small, elongate. Sculpture of 38 to 41 narrow radial ribs. Apices of anterior ribs with distinct evenly spaced scales; median ribs very narrow with vertical sides and apices overhanging interspaces, in profile resembling rails. Posterior 6-8 ribs irregularly rugose but not nodulose or spiny, apicices overhanging interspaces but more towards the anterior, in profile resembling breaking waves; the trailing edge if the apices are grooved and serves to distinguish the posterior ribs from the median ribs. Hinge line narrow and curved. Both valves with two cardinal teeth, the uppermost smaller. Left valve with marginal posterior lateral and submarginal anterior lateral each with a poorly defined socket below; right valve with with distinct anterior and posterior lateral sockets but only the ventral anterior lateral is strongly developed. Inner margin deeply crenulate. Most shells faded but these indicate that they had an irregular pattern of pink, white and straw coloured markings; internally margin tinged orange pink along posterior edge and lightly suffused pink or orange pink over the umbonal cavity.

#### Measurements (mm)

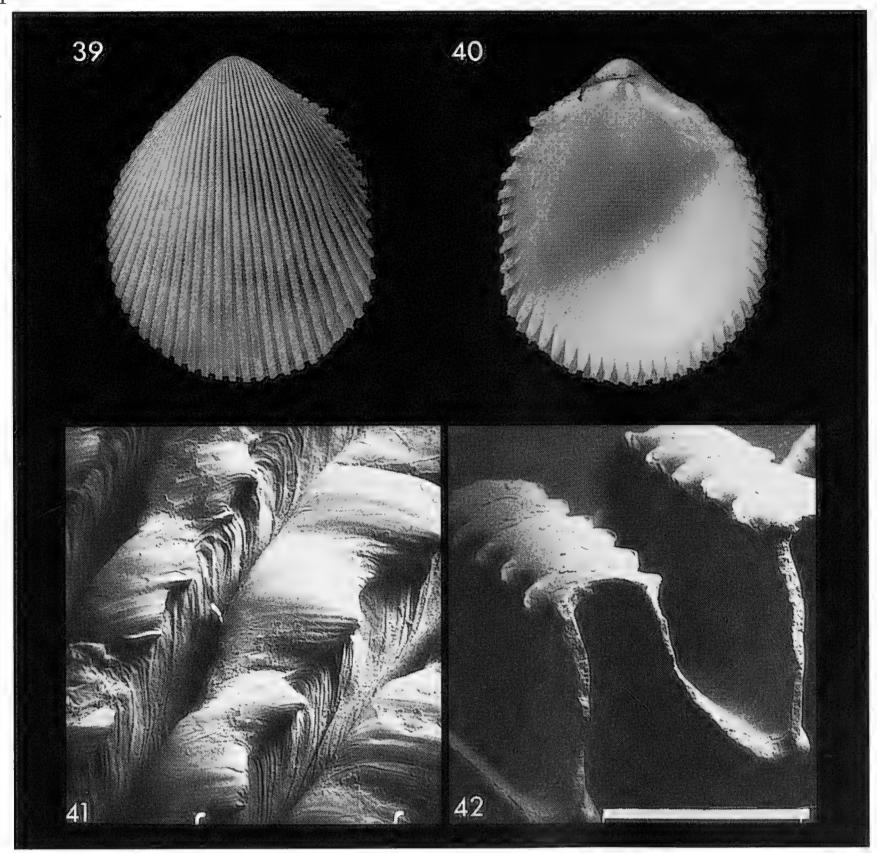
	Height		Rib No	Post		Height		Rib No	Post
Length		Tumidity		Rib No	Length	O	<b>Tumidity</b>		Rib No
<sup>H</sup> 28.9	34.7	12.2	41	7	27.4	32.4	11.0	38	6
<sup>P</sup> 28.3	33.0	12.3	41	7	27.2	32	11.1	40	7
<sup>P</sup> 26.6	32.0	10.7	40	7	26.4	30.6	11.0	39	7
<sup>P</sup> 23.3	27.9	9.8	41	7	21.2	24.3	9.0	39	6
<sup>P</sup> 23.3	27.5	9.3	39	7	38.7	46.6	17.3	41	7
44.3	57.5	19.9	39	6	36.1	43.1	14.7	38	7
46.3	57.1	18.6	39	7	33.0	39.5	13.7	39	6
42.1	52.2	18	41	8	33.2	41.5	14.1	40	7
39.7	49	17.3	40	7	32.4	38.4	13.8	40	7
39.5	48	16.5	40	7	30.5	35.8	12.6	41	7
H = holotype, $P = paratype$									

Derivation of name rhegminum, from the Greek rhegmin "a line of breakers" here referring to the posterior ribs which resemble breaking waves in the way that their apices overhang the inter rib spaces.

Distribution To date this species is known only from Khalij (Bay of) Masirah, 19°N to 20.7°N on the south coast of Oman.

Despite the many species of Indo-Pacific Trachycardium in the early literature many new taxa have been added over the last twenty years. We found it disconcerting that we should be concluding that some species from the Arabian region should not fall within those already described. We suspect that there may be considerable local variation within the genus and that many of the taxa already in literature may have only varietal status. Trachycardium rhegminum however is not distinguished on colour or outline proportions but is instantly recognisable by the form of the posterior ribs. Posterior rib

sculpture in *Trachycardium* can be weak, spinose or nodulose but we have found no other species where the apices are not interrupted or where they are so high and overhang the interspaces.



**Figs 39–42** *Trachycardium rhegminum* n. sp.: **Figs 39–40** BM(NH), Holotype, Off Ras Madrakah, Masirah, height = . **Fig. 41** SEM of posterior rib sculpture, Scale bar = 1mm. **Fig. 42** SEM showing cross section of median ribs, Scale bar = 1mm.

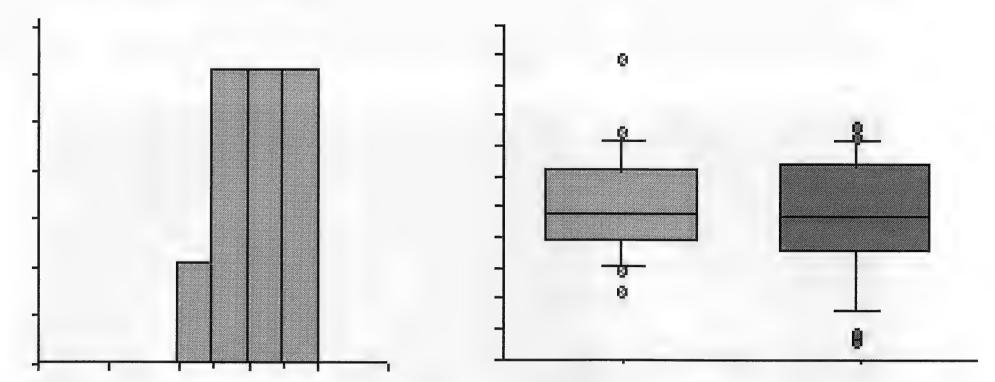
TELLINOIDEA TELLINIDAE TELLININAE

Genus **Moerella** Fischer 1887 Type species: *Tellina donacina* Linnaeus 1758

*Moerella muscatensis* n. sp. Figs 45-48

Holotype 1v, off Seeb, Muscat-Fujayrah, Oman, 23°37'N 58°36'E, dredged from 100 feet depth, i.1993, Leg. D.Bosch. NMW.Z.1996.131.118.

Paratypes 12 live collected specimens as holotype, NMW.Z. 1996.131.119.



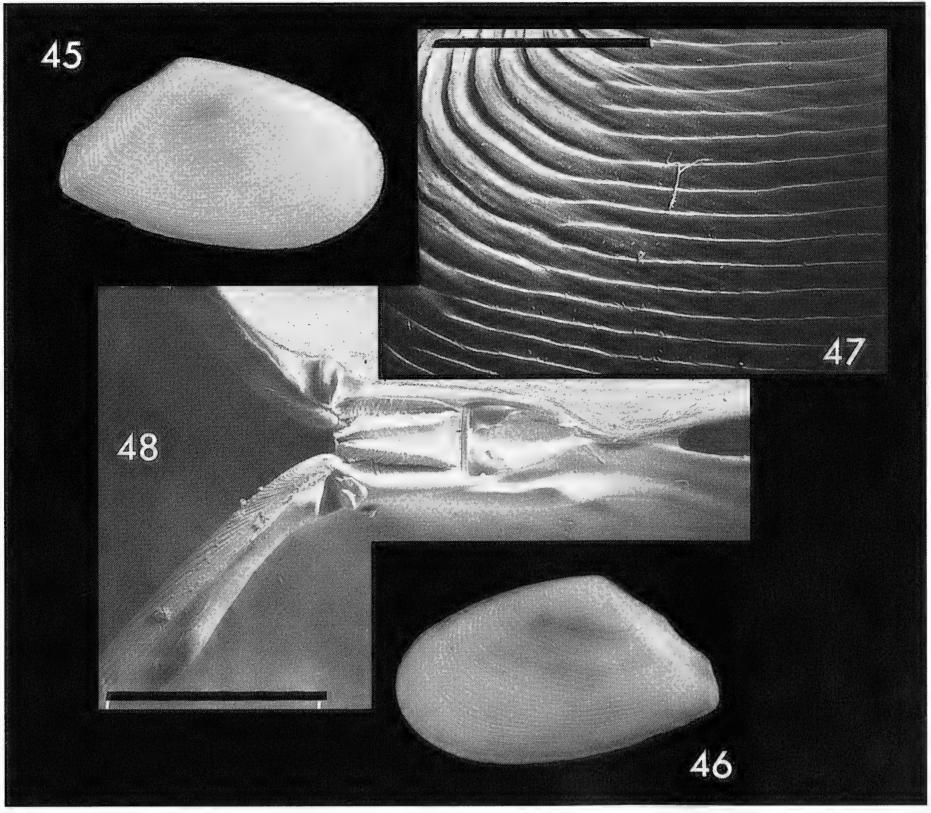
**Fig. 43** Bar chart showing the frequency distribution of rib number for *Trachycardium rhegminum*. **Fig. 44** Box plots of 'Height to Length' and 'Length to Tumidity' ratios for *Trachycardium rhegminum*.

Other material examined >20 spec. + v as Holotype, NMW.Z. 1996.131.121. >50v, Seeb, Muscat-Fujayrah, Oman, 23°41'N 58°11'E to 23°37'N 58°36'E, strandlines, Leg. D.Bosch. 10 spec. + v, Rams, Ras al Khaymah, 25°45'N 55°55'E, strandline on beach, 22.i.1993, Leg. S.P.Dance, NMW.Z. 1993.061.0760. 1v, Azaibah, Muscat-Fujayrah, Oman, 23°37'N 58°30'E, Leg. K. Smythe, NMW.Z. 1995.008.168. 2v, Azaibah, Chesney/Oliver Col. NMW.Z. 1993.061. 7 samples from sites on Masirah. 5 spec., Khor Rowri, Ras Hasik, Yemen, Leg. K. Smythe, NMW.Z. 1995.008.173. NMW.Z. 1 spec., Abu Dhabi, 24°30'N 54°30'E, Leg. K. Smythe.

Type locality Seeb, Muscat-Fujayrah, Oman.

Description Shell to 13 mm, rather solid for a small tellin. Compressed, Slightly inequivalve, posterior twist slight. Strongly inequilateral posterior greatly reduced. Outline subovate-subrostrate, rather narrow, anterior narrowly rounded, posterior narrow, obliquely truncated, posterior area demarcated by an angled ridge but not carinate. Sculpture of well spaced oblique lirae over the anterior area of both valves coalescing with concentric ridges over posterior of RV but fading into weak lines on LV. Hinge teeth of paired cardinals and strong single anterior and posterior laterals in RV; paired cardinals in LV rapidly becoming single by ligament encroachment on posterior tooth, laterals present as marginal projections only. Ligament external, nymph sunken. Adductor scars subequal. Pallial sinus very deep touching posterior adductor, cruciform muscles scars visible. Inner margin smooth. Shell white.

Holotype Paratype	Length 10.3 11.7	Height 6.0 6.9	Tumidity 3.4	open pair both valve
Paratype	12.1	7.1	3.3	Dotti vaive
Paratype	12.5	7.2	~	**
Paratype	11.2	6.6	3.4	**
Paratype	12.0	7.0	3.3	11
Paratype	11.8	6.5	3.2	11
Paratype	9.6	5.0	2.5	11
Paratype	11.6	7.0	3.0	ŤŤ
Paratype	11.6	6.7	3.0	**
Paratype	11.2	6.3	3.0	**
Paratype	10.3	6.0	2.8	\$ ?
Paratype	10.1	6.1	-	open pair



**Figs 45–48** *Moerella muscatensis* n. sp.: **Fig. 45–46** (NMW.Z.1996.131.118), Holotype, off Seeb, Oman, length = 10.3mm. **Fig. 46** SEM of sculpture on RV, Scale bar = 1mm. **Fig. 48** SEM of hinge, Scale bar = 1mm.

Measurements (mm)

Derivation of name muscatensis "Muscat" capital of Oman and "ensis" L. suffix denoting place from where one comes, after the region where this species has been most commonly found.

Distribution From Abu Dhabi in the SE. Arabian Gulf and all along the coast of Oman to Dhofar.

Remarks The generic divisions of the Tellininae are numerous and often monospecific. Characters present in our species such as the oblique sculpture and strong lateral teeth are used to define various groups and carry different weighting. If the sculpture is most important then the genus *Ouardia* is appropriate but that taxon is also defined on having a strong internal rib. If the hinge character is most important then *Moerella* is appropriate. At this time we have no critical evidence to assess the relevance of previously defined genera so choose subjectively in giving the shape and hinge characters more importance than sculpture and consequently adopt *Moerella*.

A surprising finding is that this rather common species is nowhere present in the Townsend collections which formed the basis of Melvill's descriptions. The only indica-

tion of oblique sculpture is given for *Tellina lechriogramma* Melvill, 1892 but that species is a member of the genus *Cadella* and lacks the subrostrate form. *Tellina sericata* Melvill, 1898 also has oblique sculpture but it also has posterior ridge spines and belongs to the genus *Obtellina*. *Tellina* (*Fabulina*) *tomlini* Salisbury, 1934 has weak oblique sculpture but has a weak hinge with only a short proximal anterior lateral quite unlike the strong lateral in our species. We have searched through all literature and examined relevant types especially those of Hanley but have been unable to find any descriptions which could relate to this form.

MYOIDEA MYIDAE

Genus *Cryptomya* Conrad, 1848 Type species *Sphaenia californica* Conrad, 1837

*Cryptomya thryptica* n. sp. Figs 49-52

Cryptomya sp. Oliver in Dance, 1995: 277, Fig. 1248.

Holotype 1sh, Al Jubayl, Saudi Arabia, Leg. M.Richmond, NMW.Z. 1995.022.001.

Paratype 1sh, as Holotype. NMW.Z. 1995.022.002

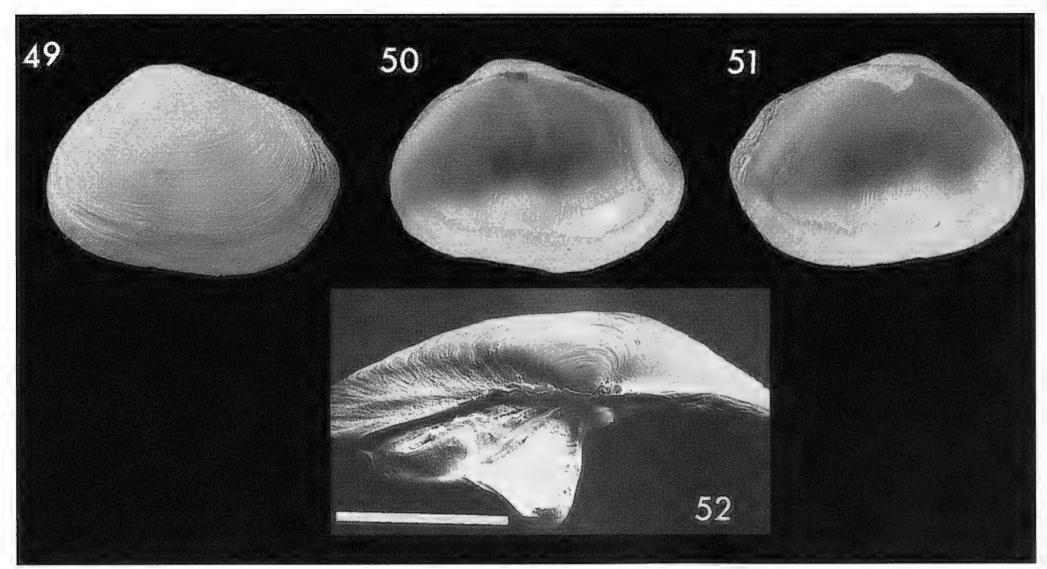
Description Shell to 11mm. Thin, somewhat inflated, approximately oblong in outline but a little irregular. Inequilateral, prosogyre beaks slightly in front of midline, anterior slightly shorter and narrower than posterior; both lateral margins rounded, ventral almost straight. Sculpture of fine incremental lines only with growth stops and the occasional dent or irregularity. Periostracum thin but persistent posteriorly, wrinkled and pale brown in colour. Hinge in LV of a massive projecting flange shaped chondrophore not extending anteriorly beyond beak but with an obsolete tubercle below beaks in some shells; anterior edge of chondrophore slightly reflected with anterior portion only slightly excavated, anterior and posterior portions of chondrophore roughly equal in size; RV with a simple shallow resilium set deep inside the umbo. Adductor scars subequal, pallial line wide with a shall crescentric sinus. Shell white.

Derivation of name thryptica from the Greek thryptikos meaning easily broken, brittle.

Remarks The only other species of Cryptomya recorded from the Arabian region is C. elliptica (A. Adams, 1851) (Figs 53–55) but that species is quite different in possessing a distinct sculpture of anterior radial lines and posterior pustules. The chondrophore of this species extends anteriorly and incorporated a prominent peg-like tooth; this corresponds to the obsolete tubercle in C. thryptica. The proportions of the chondrophore are also different in C. elliptica in that the anterior portion is at least three times wider than the posterior. In proportions of the hinge C. elliptica is very similar to the type species of the genus C. californica but in the latter the anterior peg is not visible but may be absorbed into the anterior extension. Very few studies have been made on this group of Myidae but we have examined all taxa described by Adams (1851) and noted remarks made by Lamy (1927). In these investigations we have been unable to find any species matching the Arabian form and conclude that it is undescribed.

It is of interest to note that it is sympatric with *C. elliptica* living in muddy sands in

shallow water.



**Figs 49–52** *Cryptomya thryptica* n. sp.: **Figs 49–51** (NMW.Z. 1995.022.001), Holotype, Al Jubayl, Saudi Arabia, Arabian Gulf, length = 10.4mm. **Fig. 52** SEM of chondrophore, Scale Bar = 1mm.

#### **INSTITUTIONAL ABBREVIATIONS**

NMW	National Museum of Wales before 1970
NMW.Z	National Museum of Wales after 1970
MNHN	Musee Nationale d'Histoire Naturelle, Paris
BM(NH)	Natural History Museum, London
UCMZ	University of Cambridge Museum of Zoology

#### **ACKNOWLEDGMENTS**

We would like to thank all those who kindly gave materials used in this study namely Don Bosch, Peter Dance, Martyn Day, Steve Green and Matt Richmond and without their generosity this work could not have taken place. Also to Ian Killeen who helped to prepare the manuscripts, Kevin Thomas who did the photography, Jaques Vidal for helpful discussions on cardiids, Kathy Way for access to the collections in the Natural History Museum. and to the National Museum of Wales for supporting the study.

#### REFERENCES

ADAMS A. 1851 Monograph of *Sphaenia*, a genus of lamellibranchiate Mollusca. *Proceedings of the Zoological Society London* **18**: 86–89.

Bernard F.R. 1983 Catalogue of the living Bivalvia of the eastern Pacific Ocean. Canadian Special Publication of Fisheries and Aquatic Science Ottawa 61.

Bernard F.R., Cai Y.Y. & Morton B. 1993 Catalogue of the Living Marine Bivalve Molluscs of China. Hong Kong University Press, Hong Kong, 146pp.

BIGGS H.E.J. 1973 The marine Mollusca of the Trucial Coast, Persian Gulf. Bulletin of the British

- Museum Natural History. Zoology 24: 343-421.
- BOSCH D. & BOSCH E. 1982 Seashells of Oman. Longman Group, London206pp.
- Chavan A. 1969 Superfamily Carditacea Fleming, 1820. In Moore R.C. (ed) *Treatise on Invertebrate Palaeontology. Part N, Mollusca 6, Bivalvia*. Vol. 2: N543–N561. Geological Society of America, Boulder, Colorado.
- CHESNEY H.C.G. & OLIVER P.G. 1994 Taxonomy of Arabian bivalves Part 2. A new species of Semele (Bivalvia: Tellinoidea) *Journal of Conchology* **35**: 33-36.
- Dall W.H. 1903 Synopsis of the Carditacea and of the north American species. *Proceedings of the Academy of Natural Sciences Philadelphia* **54**: 696–716.
- DANCE S.P. (ed.) 1995 Seashells of Eastern Arabia. Motivate, Dubai 296pp.
- FISCHER-PIETTE E. 1977 Revision des Cardiidae (Mollusques Lamellibranches). Mémoires du Muséum nationale d'Histoire Naturelle (NS) 101: 212pp. Paris.
- HABE T. 1977 Systematics of Mollusca in Japan. Bivalvia and Scaphopoda.. Hokuryu-kan, Tokyo, 373pp.
- IREDALE T. & McMichael D.F. 1962 A reference list of the marine Mollusca of New South Wales. *Memoirs of the AustralianMuseum* **11**: 1–109.
- Lamy E. 1921 Revision des Carditacea vivants du Muséum National D'Histoire Naturelle de Paris. *Journal de Conchyliologie* 66: 199–370.
- Lamy E. 1927 Revision des Myidae vivants du Muséum National D'Histoire Naturelle de Paris *Journal de Conchyliologie* **70**: 151–185.
- LYNGE H. 1909 Marine Lamellibranchiata. Results of the Danish Expedition to Siam. *Kongelige Danske Videnkabernes Selskabs Skrifter, Kjobenhavn* (Series 4) **5**: 97–299.
- MELVILL J.C. & STANDEN R. 1907 The Mollusca of the Persian Gulf, Gulf of Oman and Arabian Sea, as evidenced mainly through the collections of Mr. F.W. Townsend, 1893–1900. Part II Pelecypoda. *Proceedings of the Zoological Society London* **1906**: 783-848.
- NARDINI S. 1937 Molluschi delle spiagge emerse del Mar Rosso e deli' Oceano India. Parte II (Lamellibranchi). *Palaeontographia Italica* 377: 254.
- OLIVER P.G. 1995 Bivalvia in S.P. Dance (Ed.) Seashells of Eastern Arabia pp. 194–281, Motivate, Dubai.
- OLIVER P.G. & CHESNEY H.C.G. 1994 Taxonomy of Arabian bivalves Part 1. Arcoidea. *Journal of Conchology* 35: 15–32.
- OLIVER P.G. & GLOVER E., 1996. *Paphia (Protapes)* (Bivalvia): Veneroidea) in the Arabian Sea, with description of a new species. *Journal of Conchology* **35**: 389–405.
- SOWERBY G.B. 1840 The Conchological Illustrations Part 183, Fig. 66.
- THIELE J. & JAECKEL S. 1931 Muscheln der Deutschen Tiefsee-Expedition. Wissenschaftliche Ergebnisse der Deutschen Tiefsee-Expedition Alfred Wegener, 1929 und 1930–31 Leipzig 21: 161–268.
- VIDAL J. 1993 Variability of *Acrosterigma elongatum*, a polytypic species (Mollusca, Cardiidae). *Journal of the Malacological Society of Australia* **14**: 41–58.
- Wilson B.R. & Stevenson S.E. 1977 Cardiidae (Mollusca, Bivalvia) of Western Australia. Western Australian Museum Special Publication No. 9 pp114. Perth.
- VOSKUIL R.P.A. & ONVERWAGT W.J.H. 1991 The taxonomy of the genus *Trachycardium* (Part 1) with descriptions of three new species. *Vita Marina* 41: 56-70.

# NOTE ON *POTADOMA GANAHLI* CONNOLLY, 1930 (PROSOBRANCHIA, VIVIPARIDAE)

The list of taxa collected by C.R.S. Pitman given in my account of that collector¹ omits mention of Potadoma ganahli Connolly<sup>2</sup>. This was found by Pitman in the famous Kaiso Beds (popularly the 'Kaiso bone-beds') in Uganda, Bunyoro District, at a cliff south of the R. Howa, Lake Albert. The holotype is preserved in the Dept. of Palaeontology, British Museum (Nat.Hist.) (registration number G 71489). An investigation into its present status led to results more suitable for publication in the journal than as an addendum in the newsletter. References are given in the final synonymy. W. Adam (1957) and W. Adam and Lepersonne (1959) tentatively referred Connolly's species to Viviparus carinatus Fuchs but A. Charig in A. Gautier (1970) pointed out that this is a later homonym and renamed it V. worthingtoni. He states 'The record of Potadoma ganahli by Connolly----- probably refers to V. worthingtoni. All recent tropical African and Asian species once referred to Viviparus are now placed in the genus Bellamya and it is reasonably presumed that the Pleistocene species are congeneric. Connolly's type is not in poor condition and there seems no doubt that Adam and Lepersonne's tentative synonymy is correct which leads to the conclusion that Connolly's epithet is the correct one. The synonymy is set out below.

Bellamya ganahli (Connolly)

Viviparus carinatus Fuchs in Journal of the Linnean Society Zoology 40: 94, pl. 3, figs. 11, 12 text fig. 1 (1936); W. Adam Exploration du Parc National Albert. Mission J. de Heinzelin de Braucourt 3: Moll. quatern. rég. Lac Edouard. Inst. des Parcs Nationaux Congo Belge: 27, 33, 38 Brussel (1957); W. Adam & Lepersonne Moll. pléistocènes rég. Lac Albert et Semliki. Annales du Musée Royal du Congo Belge Série in 8° Sciences Géologiques 25: 18 (1959) non Swainson.

V. worthingtoni A. Charig in A. Gautier in Annales. Musée Royal de l'Afrique Centrale Série in 8° Sciences Géologiques 67: 88, pl.. I, figs 21–24, pl. II, figs. 1,6 & 7 (1970) nom. nov.

pro V. carinatus Fuchs.

I am grateful to John Cooper for information about the holotype.

B. VERDCOURT, Royal Botanic Gardens Kew Richmond Surrey, TW9 3AB

<sup>&</sup>lt;sup>1</sup> Verdcourt B. 1994 Conchologists' Newsletter No.131 **7(3)**: 417–423.

<sup>&</sup>lt;sup>2</sup> CONNOLLY M. 1930 Journal of Conchology 19: 24, figs 2a, b, c.

## MORE RECORDS OF CHARONIA LAMPAS (L.), A RECENT RECORD OF PTERIA HIRUNDO (L.) AND A MARINE SLUG TYLODINA PERVERSA GMELIN NEW TO BRITAIN

Charonia lampas (L.), the largest British - and Mediterranean - gastropod which feeds on echinoderms (mainly starfish), ranges from the Mediterranean to the extreme southern parts of Britain, but north of the Bay of Biscay it becomes sporadic in its occurrence; it is a "surprisingly unknown animal despite the conspicuousness conferred by its large size" whilst Lelong² writes that little is known of this animal and still less of its reproduction and life cycle; he adds that it is one of the species being considered as worthy of protection in the Mediterranean.

Documented records are from the Channel Isles (Sea Area 17) where "three or four "were taken in in 1825 and 1847³ and another three in 1972⁴, off County Kerry (Sea Area 37) where four were collected in 1970-71⁵; one off the Cornish coast in 1975 (Sea Area 18)⁶

and three E. of Dover (51 N 1.30 E) in 19867.

A few other records have been so far undocumented. Ms Vicky Irlam, Keeper of the Plymouth Marine Aquarium tells us that in about 1970 a specimen was brought to the Aquarium; although the provenance is now unknown, she thinks that it is likely to have been from the Bay of Biscay, frequently visited by the Marine Association's research vessel *Sarsia* three decades ago. It transpired that this example of *Charonia lampas* was a male and when a female was brought in, dredged 2 miles off Fowey (Sea Area 18) in July 1979, the male immediately joined her and pairing (which takes 2–3 hours) took place in the autumn. They are both still alive in 1997 and have produced spawn in late October–November every year since 1979 except in 1996 when a move to another tank upset their routine\*. In June 1997, Mr Jeremy Rule of the fishing vessel *Sovereign* dredged a large specimen (265 x 140 mm) in Falmouth Bay (Sea Area 18) and it was given to PAG who was able to make a photographic record before releasing it back into the Bay, an event shown on regional television. He later saw and photographed the shell of a second specimen (230 x 115 mm), taken alive, in January 1996 off Black Head (Sea Area 18 in SW71), and now gracing the mantelpiece of the finder, Mr Michael Sleeman.

During 1996 Mr Stephen Long, a fisherman, presented PAG with another rare 'southern' species, *Pteria hirundo* (L ) which he had found living on the anthozoan *Eunicella* 

verrucosa (Pallas) in St Austell Bay (Sea Area 18 SX05).

In 1996 and again in 1997 Mr Jon Makeham found a marine slug *Tylodina perversa* Gmelin on the shore at Looe in Sea Area 188 a species normally found only in the Mediterranean area, west to Madeira, and never before recorded in the British Marine Area.

Taken in conjunction with reported occurrences of some species of fishes extending their range northwards9 these molluscs may well be taken as a further indication of a

warmer phase.

\*Ms Irlam has kindly supplied us with the relevant 'Notes from the Aquarium records' between 1979 and 1984. "When the female starts laying she sits on the eggs like a hen, covering them as much as she can with her body. He leaves her and returns to mate before she lays the second batch and so on - I think she lays 3 or 4 batches. As far as I have seen she does not leave her eggs at all until they have started to hatch, when she may go a short distance from them for a short time before she returns to sitting until they have all hatched, As far as I have seen they hatch in February-March. When she finally does leave them, she is hungry and travels round the tank eating. They do not appear to come into contact with each other, and in fact avoid each other in the tank until it is approaching the mating season." She adds that none of the larvae have been

obtained, probably having been eaten by various fish species that share the tank. This agrees with (?the first) published account¹⁰ describing spawn laid in a tank at the Institut Oceanographique where a pair of *C. lampas* are reckoned to have produced 5 million eggs over 3 years. However the suggestion that the species is nocturnal is not borne out by observations in the Plymouth Marine Laboratory aquarium by Ms Irlam.

- <sup>1</sup>Fretter & Graham 1981 Journal of Molluscan Studies Supplement 9.
- <sup>2</sup> Lelong 1993 Oceanorama No. 21.
- <sup>3</sup> Jeffreys J.B. 1858 Annals and Magazine of Natural History 2 p. 130.
- <sup>3</sup> Crowley T.E. 1961 Journal of Conchology 25 pp. 17–20.
- <sup>4</sup> Brehaut R.N. 1973 Journal of Conchology 28 pp. 41–42.
- <sup>5</sup> O'RIORDAN C.E. 1972 Journal of Conchology 27 pp. 371–372.
- <sup>6</sup> Turk S.M. 1976 Journal of Conchology 29 pp. 29–30.
- <sup>7</sup> DE LIGT 1987 Journal of Conchology **32** p. 385.
- <sup>8</sup> Makeham & Webb 1997 Glaucus 8 p. 39.
- <sup>9</sup>SWABY & POTTS 1991 & 1993 Zoological Cornwall and the Isles of Scilly Nos 1 & 2
- <sup>10</sup> Lelong 1993 Oceanorama No 21.

P.A. Gainey and S.M. Turk

# MODIOLUS LULAT (DAUTZENBERG, 1891): A TROPICAL WEST AFRICAN BIVALVE RECORDED FROM SOUTH EUROPEAN COASTS.

The South of the Iberian Península is a Northern biogeographic limit for many West African species of Molluscs. Examples within the bivalves are *Macoma melo* (Sowerby, 1866), which reaches the Alboran Sea, or *Gari pseudoweinkauffi* Cosel, 1990, which reaches the Straits of Gibraltar and Algeria. *Modiolus lulat* (Dautzenberg, 1891) which has a tropical West African distribution, and which is here recorded in the littoral of Málaga (Southern Spain) and is one more example of this pattern.

We have collected, in September 1996, 4 living specimens and 3 shells from Calahonda (near Marbella, prov. Málaga, 36°29′N, 4°44 W), among rocks with algae and silty gravel in 1-2 m. We also examined an additional valve from the same locality (leg. Gofas 8/1981), Moroccan material (leg. Bellon-Humbert and Gantès 1969), and the West African material from Mission Gruvel¹, all in Muséum National d'Histoire Naturelle,

Paris (MNHN).

Modiolus lulat was named after Adanson's "Perna 1. Le Lulat"<sup>2</sup>, of which the original specimens are lost<sup>3</sup>. The name was validly introduced as Modiola lulat by Dautzenberg<sup>4</sup> based on a reference to Adanson and on additional West African material. M. lulat was previously known from Morocco (Pasteur-Humbert, 1962)<sup>5</sup> to Guinea and from Ivory

Coast (Cosel, unpublished).

Modiolus martorelli (Hidalgo, 1878) somewhat resembles M. Iulat and has been repeatedly mistaken for it; however M. martorelli<sup>6</sup> is larger, with the ligament extending over two thirds of the total length (not more than half in M. lulat), the postero-dorsal margin is convex, (concave in M. lulat); its periostracum is smooth with oxyde crusts, not hairy as in M. lulat. Contrary to M. martorelli which has a dull shell, the shell of M. lulat has a vivid reddish colour, more visible towards the umbo, and inside has dark rays in the dorsal area. The distribution of M. martorelli seems to be a puzzling disjunction; there are records in the Western Mediterranean (type locality in Benicarló, prov. Valencia, Eastern Spain) to Western Sicily and Tunisia (Cosel, unpublished data); then only in Southern Morocco "Vanneau" expedition 1926. Off Agadir, 115 m; MNHN, unpublished) and West Africa (Ivory Coast and around the mouth of the Congo, material in MNHN).

- <sup>1</sup> Dautzenberg P. 1913 Annales de l'Institut Océanographique 5: 85.
- <sup>2</sup> ADANSON M. 1757 *Histoire Naturelle du Sénégal* Claude-Baptiste Bauche, Paris 207 pl. 15 fig. 1; non binomial.
- <sup>3</sup> FISCHER-PIETTE E. 1942 Journal de Conchyliologie 85: 298.
- <sup>4</sup> Dautzenberg P. 1891 Mémoires de la Société Zoologique de France 4: 55.
- <sup>5</sup> Pasteur-Humbert C. 1962 Travaux de l'Institut Scientifique Chérifien sér. zoologie 28: 23 pl.5 fig.19.
- <sup>6</sup> HIDALGO J.G. 1878 Molluscos marinos de España 1: 129 pl. 75 fig. 6.

J. Rueda and C. Salas Dept. Biología Animal Facultad de Ciencias Universidad de Málaga 29071 Málaga Spain

## AN OFFSHORE HABITAT FOR AN EASTER ISLAND BIVALVE

The offshore environment of Easter Island has been surveyed down to a depth of 60 meters<sup>1</sup>. Recently the author analysed the contents of two box dredges collected in 1958 in La Perouse Bay on the north coast of Easter Island by the ship *Horizon* on the 'Downwind' expedition of the Scripps Institution of Oceanography of the University of California, San Diego. One dredge was collected at a depth of 40 to 100 meters and the other at a depth of 132 to 174 meters.

With reference to bivalve material, the following was found: 40 to 100 meters Single valves of *Chama iostoma* (Conrad, 1837) and *Malleus maculosa* (Reeve, 1858); 132 to 174 meters Single valves of *C. iostoma, H. maculosa, Semele australis* (Sowerby, 1833) and *Limaria fragilis* (Gmelin 1791). Five pairs with animals of *Barbatia nuttingi* (Dall, Bartsch, and Rehder, 1938).

Barbatia nuttingi pairs were found in the pores of coral rubble. The presence of these in the dredge material indicates the presence of this bivalve in the offshore habitat of Easter Island at a depth of 132 to 174 meters. Previously, *B. nuttingi* had been reported as inhabiting the intertidal zone of Easter Island<sup>2</sup>.

The author thanks Warren Smith of the Geological Collections at Scripps Institution of Oceanography for making the dredge materials available. The specimens from the dredges are in the Benthic Invertebrate Collection of the Scripps Institution of Oceanography.

<sup>1</sup> DISALVO L. H., RANDALL J. E. & CEA A. 1988 National Geographic Research 4 pp. 451–473.

## ON THE OCCURRENCE OF MAUREA WAIKENAE OLIVER, 1926 (GASTROPODA: TROCHIDAE)

The New Zealand trochid species *Maurea waikenae* (Oliver, 1926) has a questionable status as a separate species from *Maurea selecta* (Dillwyn, 1817) because it has not been found in separate populations<sup>1</sup>. The shell of *M. waikenae* differs from that of *M. selecta* in having continuous pattern from the dorsal side to the ventral side, brown colouration on the dorsum and a smaller size.

Recently an analysis of molluscan material from a rock dredge collected on the Monsoon expedition of the Scripps Institution of Oceanography of the University of California, San Diego yielded five specimens of *M. waikenae*. The dredge haul was made at a depth of 88 fathoms on January 31, 1961 in waters east of New Zealand (43°30′S, 177°26′E). The specimens are in the Benthic Invertebrate Collection of the Scripps Institution of Oceanography. One live collected (SIOBIC M7003) and four dead collected (SIOBIC M7004) comprise the specimens found.

It is important to note here that no specimens of *M. selecta* were found thus supporting the idea that *M. waikenae* is a distinct species from *M. selecta*.

The author wishes to thank Spencer Luke of the Benthic Invertebrate Collection of the Scripps Institution of Oceanography for his assistance in this investigation.

<sup>&</sup>lt;sup>2</sup>Osorio C. & Cantuarias V. 1989 Pacific Science 43 pp. 302–315.

<sup>&</sup>lt;sup>1</sup> POWELL A.W.B. 1989 New Zealand Mollusca Collins: Auckland 500 pp.

# A SOUTHERN RANGE EXTENSION FOR AN AMERICAN WEST COAST BUCCINID

The buccinid *Neptunea tabulata* (Baird, 1863) occurs off the west coast of North America south to Newport Bay, Orange County, California<sup>1</sup>. However a specimen of this species in the Benthic Invertebrate Collection of the Scripps Institution of Oceanography of the University of California, San Diego is evidence that this species occurs south of this location. A 110 mm specimen of *N. tabulata* (Catalogue Number SIOBIC H7000) was collected at the Coronado Banks (32° 37′N, 117° 25′W) off the coast of San Diego approximately 100 miles south of the Orange County, California location. It was live collected at a depth of approximately 180 meters by submersible on December 22, 1964.

The author wishes to thank Spencer Luke of the Benthic Invertebrate Collection of the Scripps Institution of Oceanography for his assistance in this investigation.

<sup>1</sup>McLean J.H. & Gosliner T.M. 1996 *Taxonomic Atlas of the Benthic Fauna of the Santa Maria Basin and western Santa Barbara Channel. Vol. 9 The Mollusca Pt. 2 — The Gastropoda,* Santa Barbara Museum of Natural History pp. 1–228.

# THE FIRST BLACK ABALONE HYBRID IN NATURAL POPULATIONS

The black abalone *Haliotis cracherodii* (Leech, 1814) has been crossed with the green abalone *Haliotis fulgens* (Philippi 1845) and the pink abalone *Haliotis corrugate* (Wood, 1828) in aquaculture conditions however, *H. cracherodii* has not been involved with the production of hybrid abalone in natural populations<sup>1</sup>. Recently a mature abalone shell found by commercial fisherman somewhere on the west coast of Baja California was identified by abalone researcher Buzz Owens as a hybrid of *H. cracherodii* and *H. corrugata*. The shell is in the reference collection of shell dealer Don Pisor of San Diego, California.

The specimen is 162 m. in length. The shell's colour is similar to that of *H. cracherodii* and the morphology is *H. corrugata*. The colour of the dorsum is dark blue with some black which is a normal colour pattern for *H. cracherodii*. The morphology of the dorsum has irregular diagonal rows of nodes or corrugations and raised shell holes which are morphological characteristics found on the shell of *H. corrugata*. The ventral interior is similar to *H. cracherodii* in having a faint muscle scar.

<sup>1</sup>LEIGHTON D.L. & LEWIS C.A. 1982 International Journal of Invertebrate Reproduction 5 pp. 273–282.

Kent D. Trego Nautilus Malacology Institute 441 Ravina Street #3 La Jolla California, 92037 USA

## **REVIEWS**

Coquillages de Djibouti by Alain Coulombel, 1993, Editions Edisud, La Calade, RN7, 13090 Aix en Provence, France. 143 pp. ISBN 2-85744-707-8. Available from the Publishers, price 260 Francs (approx. £29).

This book serves as a good introduction to the Marine shells of Djibouti, a small state at the mouth of the Red Sea, between Ethiopia and Somalia and opposite to Aden. As France is the former colonial power it is fitting that this study should have been published in France. The text is in French, but illustrations explaining the specialist terms used in the descriptions help make it easy to follow. The introduction includes details of local habitats and a section on conservation and it is interesting to note that such a small state should have two Marine National Parks.

The bulk of the book consists of detailed descriptions of the species covered - some 200 Gastropods and 40 Bivalves - accompanied with superb quality colour photographs, most life size or larger, showing dorsal and ventral views of each Gastropod and interior and exterior views of each Bivalve. Maps clearly show the local distribution of each species and there is an indication of the frequency with which each shell occurs in Djibouti, There is no indication of the species wider distributions outside Djibouti and the use of local frequency only can be confusing — Cypraea moneta, for example, is considered rare and Cypraea pulchra abundant The number of species covered is limited concentrating on those larger species which will more commonly be found, and it is a pity that many smaller species occurring in the area are not included. There are, however, a number of unusual species illustrated. I was particularly interested in the selection of Ancillas which includes A. testudae, A. djiboutina, A. albisulcata, A. acuminata, A. ventricosa, A. exigua & A. ampla. A number of Red Sea endemics are prominently featured, including Cypraea exusta, Mitra bovei, Conus erythraeensis and Homalocantha digitata, but it is surprising to find the locally common subspecies Strombus gibberulus albus shown as S. gibberulus.

The large format - 25 cm x 29 cm - make the book a little unwieldy to handle, it could certainly not be used as a field guide, but it is well laid out and easy to use with a good bibliography and index. It can certainly be recommended as a good introductory guide

to the shells of Djibouti but is limited in coverage.

Kevin Brown

*The Algorithmic Beauty of Sea Shells* By Hans Meinhardt, 1995. Berlin: Springer - Verlag. xi + 204 pp., with 121 illustrations, mostly in colour, and 3.5" disk. Hardback. ISBN 3-540-57842-0. Price £31.45.

This beautifully produced book manages to delight the eye whilst efficiently explaining elegant hypotheses for the amazing diversity of striking patterns found on mollusc shells. The explanations are ultimately in terms of reaction-diffusion equations, but no mathematics is needed to follow the arguments. A simple example of the kind of model is of one substance, the activator, that promotes production both of itself and of another substance that inhibits production of the activator. This can cause the concentration of activator to vary in a wave-like manner, undulating either in space or in time, this depending on the relative diffusion and decay rates of activator and inhibitor. Meinhardt envisages that at each point along the strip of mantle tissue around the shell aperture the concentration of activator determines whether pigment is produced. The

beauty of molluscs is that as the shell grows it lays down a historical record of how the distribution of pigment production changes. Reaction-diffusion equations are much invoked in the embryology of other organisms, so the audience for this book should not be restricted to malacologists.

Although the more involved models in the later chapters do inevitably require more concentration, the writing is clear, helpfully structured and never plodding. Occasional allusions to such non-molluscan phenomena as sand dunes, candles and the economy, are not only fun but also illuminating. The algebra is restricted to a few boxes, whilst the main text explains the output of the models intuitively. The numerous colour illustrations, of excellent shell photographs side-by-side with the graphical output of the computer; models, are closely integrated with the text and helpfully amplify the explanations. Really the book would be worth buying just for the illustrations, since, even if one has no interest in underlying mechanisms, the book is valuable as a catalogue of the diversity of patterns. An added bonus is that a disk is included containing the program that generated nearly all the outputs illustrated. It is straightforward to run on any IBM compatible computer, the parameters for each published illustration can be read from the disk, then these parameters can be altered or, if you really do get involved, the original source code is provided.

Is there good evidence for the mechanisms proposed by Meinhardt? No direct physiological evidence of activator or inhibitor substances exists. With some shell patterns the simplicity of Meinhardt's explanatory mechanism is appealing, but other simple mechanisms have also been proposed, such as neural interactions. In those shells in which stripes on adjacent whorls are entrained, it seems likely that some neural mechanisms do need to be involved. One paragraph mentions some such "rival" models, but by no means all relevant papers are cited and I was disappointed that the opportunity was not taken to review the different approaches. For instance there is another school of modelling shell patterns based on cellular automata, and I remain unsure to what extent this is just an alternative way of describing the same processes. For comments on the successes and failures of these two schools, readers might look at the 1996 paper by

Kusch & Markus<sup>2</sup>.

With more complex patterns, Meinhardt has to resort to more complex models, sometimes with so many parameters that one wonders whether jiggling their values could generate any pattern, and thus whether the model is untestable. However, what I found convincing was that it was not just the broad patterning that could be made to fit, but that sometimes fine details of the shapes emerged as strikingly concordant with reality. Meinhardt does not rely just on general similarity to define what is an adequate model, but comments, for instance, on the pattern following growth disruptions, or on intraspecific variation, and he checks whether patterns in related species could be generated by related models. Unfortunately virtually no experimental manipulations have tested

Meinhardt's hypotheses, or anybody else's.

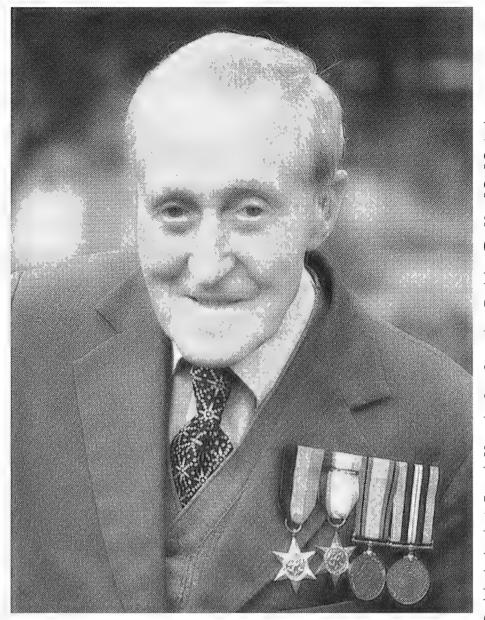
One example illustrated is the banding in *Cepaea*. This set me wondering, because we know something of the genetics of shell pattern in *Cepaea* and some other land pulmonates<sup>3</sup>. Could one relate the genetics to the substances and parameters hypothesised in the model? Even when the genetics is poorly understood, a more quantitative analysis of intraspecific variation would provide a more stringent test of the model. This should be combined with a quantitative sensitivity analysis involving altering each of the model's parameters. Perhaps this was done but only occasional qualitative results are mentioned. A formal sensitivity analysis also gives the data on which to base a classification of patterns; it is possible that apparently quite different patterns could result from a small change in a single parameter. Another issue also interests me: if Meinhardt's model of standing waves is correct, can particular bands on *Cepaea* be counted as homologous when the total number of bands differs?

The *Cepaea* example further stimulated me to question Meinhardt's complacent belief that "Presumably there is no strong selective pressure on shell pattern". He contrasts pigment patterns with shell sculpturing whose much greater consistency in pattern is ascribed to stronger selection pressures. I am worried about the claim of non-adaptation, because the polymorphism in *Cepaea* used to be dismissed as non-adaptive<sup>4</sup>, yet experiments have since demonstrated many adaptive consequences<sup>5</sup>. Some shell patterns provide such an exquisite historical record of the regularity of an individual's development that one might even predict that they should be used in mate choice! The beautiful *Clithon* shells illustrated in the book have a complex pattern of parallel lines and paler "tongues", and, although the precise patterning may not matter, the overall graininess certainly made them cryptic to me in the wild. Unfortunately, and mysteriously, many ornately patterned shells are said always to be covered up in life by sediment or an opaque coating. But rather than assuming neutrality Meinhardt could utilise his models to provide evidence of adaptation: ask what patterns that the models can generate are not observed in the wild<sup>6</sup>.

The last main chapter is not written by Meinhardt but attempts to integrate his shell patterning models with three-dimensional models of shell growth. This is potentially an important exercise since at parts of the shell near the coiling axis the growth rate is much slower and the direction of growth is almost perpendicular to that around the rest of the aperture. A blank shell cannot simply be wrapped up in the flat designs printed elsewhere in the book. But, disappointingly, this chapter introduces few new insights. The model used, the logarithmic helicospiral, is descriptive, which contrasts with the philosophy of the rest of the book of building up from a mechanism with the aim of understanding the mechanism. Some suggestions about mechanistic modelling of shell growth do exist in the literature, but probably this would have been too ambitious a task here. Unfortunately when the modelled shells are displayed next to their real counterparts, the agreement in shape around the columella is in several cases distractingly imperfect. Nevertheless the chapter does contain one delightful idea: a virtual-reality museum in which one can explore a gallery of beautiful computer-generated shells. Unlike in real museums we could inspect a shell from as close as we like—even from inside.

- <sup>1</sup> Ermentrout B., Campbell J. & Oster G. 1986 A model for shell patterns based on neural activity *The Veliger* **28**: 369–388.
- <sup>2</sup> Kusch I & Markus M. 1996 Mollusc shell pigmentation: cellular automaton simulation and evidence for undecidability. *Journal of Theoretical Biology* **178**: 333–340.
- <sup>3</sup> CAIN A.J. 1988 The scoring of polymorphic colour and pattern variation and its genetic basis in molluscan shells. *Malacologia* **28**: 1–15.
- <sup>4</sup> Huxley J. 1942 Evolution. the Modern Synthesis. George Allen & Unwin, London, 645pp.
- <sup>5</sup> Jones J.S., Leith B.H. & Rawlings P. 1977 Polymorphism in Cepaea: a problem with too many solutions. *Annual Review of Ecology and Systematics* 8: 109–143.
- <sup>6</sup> RAUP D.M. & MICHELSON A. 1965 Theoretical morphology of the coiled shell. *Science* 147: 1294–1295.
- <sup>7</sup> Hutchinson J.M.C. 1989 Control of gastropod shell shape; the role of the preceding whorl. *Journal of Theoretical Biology* **140**: 431–444.
- <sup>7</sup> MORITA R. 1991 Mechanical constraints on aperture form in gastropods. *Journal of Morphology* **207**: 93–102.

J.M.C. HUTCHINSON School of Biological Sciences University of Bristol Woodland Road Bristol, BS8 1UG



#### OBITUARY: JOHN ARMITAGE 1900-1996

Born in Oldham, Lancashire on the 16th of September 1900, Educated at the Oldham School of Art, he became a designer and landscape painter. At the age of 14 he joined Oliver's of Manchester as a lithographic and illuminating artist. His first connection with the Conchological Society happened soon after this. The Conchological Society of Great Britain and Ireland commissioned an illuminated address from Oliver's and it was John who at the tender age of 14 years illustrated this manuscript. The address was presented to John William Taylor of Leeds on the occasion of his 70th birthday in recognition of outstanding work in connection with the study of British land and freshwater shells<sup>1</sup>. This manuscript is now part of the collections held at the Leeds City Museums.

From a very young age John became a close friend and acquaintance of Fred Taylor who lived close by at 42, Lanseer Street, Oldham, and spent much of his informative

years collecting and studying natural history under him.

In 1924 he became a full-time naturalist, photographer and lecturer, joining the Foyles Lecture Agency of 125, Charing Cross Road, London, W.C.2. This freedom allowed him to travel all over Europe, the near east and even took him to Jamaica in the West Indies. He also wrote for several local and national newspapers including the Daily Mirror, the Oldham Chronicle, under the pseudonym Moorcock, and in latter years the Yorkshire Evening Post.

His early interests in Conchology, instilled into him by Fred Taylor, never left him and his extensive travels allowed him to build up an extensive British and European shell collection. John's own collection was also greatly enhanced after Fred's death when his widow allowed him to remove, in two large suitcases, most of the more important elements of Fred's collection. This extensive collection along with his field note-books and diaries and most of his photographs are now in the care of the Leeds City Museum.

John spent his wartime military service in the Royal Air Force as a photographer, and was based for a period near Kaldadarnes in Iceland. His molluscan studies at that time

were published in 1964 as a joint paper with Nora F. McMillan.

As far as I can establish John was the only person ever to have found the slug *Milax* (*Milax*) *nigricans* (Philippi, 1836) in Britain. The specimens collected on waste ground near Bexhill, Sussex were confirmed by Mr Watson and published in Quick's Monograph under the name *Milax insularis* (Leseona & Pollonera, 1882)

In 1953 he applied for and was appointed as Keeper of Biology at the Leeds City Museum on the 2nd of November under the then Director Dr W.E. Owen. John Wilfred Jackson acting as one of his referees. John remained at the museum until his retirement on the 16th of September 1969, well after normal retirement age.

Although his membership of the Conchological Society was limited, his connections with the society through the Yorkshire Conchological Society, and several other organisations, always kept him in touch with the subject.

John died in his sleep in a nursing home in Leeds on the 5th of August 1996. He leaves

87

a wife Mabel, two daughters, Helen and Heather and 4 grandchildren. He also leaves many friends and acquaintances who will always remember him.

<sup>1</sup> 1915 Journal of Conchology **14** pp. 316–319.

Adrian Norris Senior Curator Natural Sciences and Ethnography Leeds City Museum

CORRIGENDA

Nathalie Yonow (1996). Systematic revision of the family Phyllidiidae in the Indian Ocean province: part 1 (Opisthobranchia: Nudibranchia: Doridoidea). *Journal of Conchology* **35**: 438–516.

P. 483 Ffyeria picta to Fryeria

P. 485 (table) "median crest joined?" to "median crest

joined?"

P. 500 BMNH type registration numbers:

Holotype: 1996107 Paratypes: 1996108

P. 502 P. varicosa: Risbec 1929: 49, figs 10–16 (not figs 6.....8)

P. 507 specimens A and B are lodged at the BM(NH), acc. no. 2338, and specimen C is lodged at the Senckenberg Museum, Frankfurt

P. 513 first line: "...join long..." to be "...join along..."

P. 514 third line: preliminary to preliminarily

P. 514 Acknowledgements. I would like to thank the Systematics Association for a small grant towards the expenses incurred during this work.

# PROCEEDINGS OF THE CONCHOLOGICAL SOCIETY OF GREAT BRITAIN AND IRELAND

REPORT OF THE COUNCIL 1996–1997

The Society announced with regret the deaths of two members, Dr E.E. Sandor, member since 1971 and Mr A.R. Waterston, OBE, BSc, FRSE, FRES, Life Member since 1931. The death of Mr J. Armitage, member of the Yorkshire Conchological Society, was also announced.

Council Positions

Dr Preece began his second year as President of the Society. Mr Killeen stood down as Hon. Programme Secretary, and was replaced by Dr Rupert Honnor. New Ordinary Members of Council for 1996/7 were Mr Killeen, Mrs Weideli and Ms Chesney. Mr Boyce, Mr Pinn and Mrs Street began their second year on Council; Mr Palmer, Mr Brown and Miss Nelson began their final year on Council. All other Council positions remained unchanged.

**Publications** 

The Society published one issue of the *Journal of Conchology* (Volume **35**, Part 5). At the time of writing, Volume **35**, Part 6 of the Journal was being printed. Four issues of the *Conchologists' Newsletter* were published (Volume **8**, Part 1, Numbers 136–139). The Society also published the Annual Programme Card and revised Membership List and mail order form in January 1997.

Other Council Matters

While regretting the unfortunate loss of Dr Sandor, Council is grateful for the bequest he made to the Society of £1,000.

A regular item on the Council agenda throughout the year was the Molluscan Conservation Conference, held jointly by the Conchological Society of Great Britain & Ireland, the IUCN Mollusc Specialist Group and the National Museum and Galleries of Wales. The Conference, held in Cardiff in November, ensured that Mr Killeen was kept busy despite resigning as Hon. Programme Secretary. An excellent job was done by him and Dr Mary Seddon, the two organisers, in providing the first European conference on the theme of Molluscan Conservation.

The past year has been a very busy one for Council. Among the many topics discussed were Society investments, recosting of the *Journal of Conchology* and use of the Society's distribution data. A questionnaire was developed and circulated to all members to improve the service provided by the Society. The Display Boards were used, in whole or in part, at Haslemere, Reading, Dulwich, Pagham, Portsmouth and Cardiff. Council also awarded the first Research Grant since initiating this scheme last year. The maximum amount of £125 was awarded to Mrs A.J. Millar, a member of the Society, who is studying the effects of coppicing on snails at West Dean Woods in Sussex.

J E Reynolds Hon. General Secretary

#### Programme Secretary's Report - March 1997

The 1996 programme comprised 6 indoor meetings held at the Natural History Museum in London, a conference held at the National Museum of Wales, 6 field meetings and 2 workshops.

Lectures at indoor meetings were given by Fred Pinn, Dr. Richard Preece, Dave

Aldridge (University of Cambridge), Dr. Justin Gerlach (University of Oxford), Dr. Emily Glover (Institute of Archeology, London) and Christine Street.

Molluscan Conservation - A Strategy for the 21<sup>st</sup> Century was the theme of the conference held in conjunction with the National Museum of Wales over three days in November. Organised by Mary Seddon and Ian Killeen, this conference proved very

successful, with numerous distinguished speakers.

Field meetings continue to be well attended, and this year saw the first "foreign" marine field meeting held in Brittany, France (Leader: Ian Killeen). Other meetings were held at the following venues: Isle of Wight (Leader: Bill Pocok); Tilford area, Surrey (Leader: Jan Light); Norfolk Broads near Norwick (Leader: Derek Howlett); the Somerset Levels (Leaders: Tony Smith and Colin Gillard); and Highgate and Queen's Woods, North London (Leader: Jane Reynolds).

A workshop on British Slugs, tutored by Stella Davies was held at Judith Nelson's home in Woking. The Society's eleventh Molluscan workshop was again held at the home of Judith Nelson in Woking. Both of these events were great successes again.

The Society is grateful to all of those people who have contributed to the above programme, as speakers, field meeting leaders, and meeting and workshop organisers and tutors. Special thanks go to Ian Killeen for organising the 1996 Programme.

Rupert Honnor (Programme Secretary)

#### Treasurers Report 1996 (Subject to Audit)

Income exceeded expenditure by £3,745.00 and the profit for the year, after transfer to the reserve funds and adjustments to the life members fund, was £2,857.00

Income from subscription was £12,184 which is £1,540 greater than in 1995. This is almost entirely due to increased income arising from additional subscribers and institutional members.

Sales of back numbers of the publications and other goods have once again provided much needed income, raising £1,902.

The costs of publishing and distributing the Society's publications was £10,412 which is significantly less than in 1995.

Sundry costs are lower as we have not invested in the purchase of saleable items.

The life membership reserve has been calculated in accordance with the principles used last year and the fund has been adjusted to £2,990 (26 life members at £115.00 each).

A £125 grant was made from the research and reserve fund. A transfer of £718 has been made to the fund.

Other reserves includes £1,088 net income received in respect of the Molluscan Conservation Conference and being held towards the cost of printing the Proceedings.

During 1996 the investments held by the Society were rationalised. The National Investment Savings Account was closed and the money from this account, together with surplus funds held in other accounts were invested in Royal Bank of Scotland and Treasury stock.

At the end of the accounting year membership of the society stood at 372. This includes 41 institutes. Overall 19 new members were recruited in 1996. This offset the loss resulting from resignations and lapsed subscriptions, giving a net increase of 1 personal member and 5 institutional members.

In summary, the society continues to be in a good financial position, and there appears

to be no immediate need for a rise in the subscription rates.

Michael Weideli Treasurer

# CONCHOLOGICAL SOCIETY OF GREAT BRITAIN & IRELAND. ACCOUNTS FOR THE YEAR ENDED 31 DECEMBER 1996

INCOME AND EXPENDITURE ACCOUNT

	31 Dec. 1996 £	31 Dec. 1996 £						
Income Fees and Subscriptions Investment Income Sales & Donations	12,184 2,937 1,902	10,644 2,523 2,794						
	17,023	15,961						
Expenditure Publication Costs Stationery & Sundry Postage Meetings Sundry Costs	10,413 1,022 729 1,114	12,708 1,251 745 2,020						
	13,278	16,724						
Excess of Income Over Expenditure	3,745	(763)						
Transfer to Research & Reserve Transfer from Life Membership Transfer to other reserve	(718) 230 (400)	(796) 1,394						
Profit/Loss for Year	2,857	(165) ====						
Balance	BALANCE SHEET							
	31 Dec. 1996 £	31 Dec. 1996 £						
Assets Investment at Cost Cash Debtors	32,258 8,687 209	15,172 25,771 221						
	41,154	41,164						
Liabilities Creditors and Accrued Charges Advance Subscription Life Members Fund Reserve & Research Fund Other Reserves	4,022 575 2,990 8,061 1,184 ————————————————————————————————————	6,570 2,344 3,220 7,468 96 19,698						
Net Currents Assets	24,322	21,466						
Represented by: Capital Account brought fwd. Profit/(Loss) for year	21,465 2,857	21,631 (165)						
	24,322 ====	21,466 ====						
M.D. Weideli Honorary Treasurer		N. Light D. Worth						

Honorary Auditors

#### Marine Recorder's Report - March 1997

Marine recording has continued to feature in the Society's field activities. Notably during July 1996 the first overseas trip saw members participating in a week-long meeting in Brittany, France. A detailed account appears in the *Conchologists' Newsletter* no. **139** and all records obtained during the survey of shores at localities along the north

west coast represent new data for the scheme.

The project to record the distribution of marine molluscs in the Channel (DOMMIC) has become a prime focus for marine recording in southern waters. Whilst the south coast of England has been relatively well recorded in the last ten years, there are large gaps in our knowledge of the French coast, particularly east of Cherbourg, and especially for the sublittoral fauna. The results of recent recording efforts in Brittany have revealed marked differences in the fauna between the French and English side. For example species which appear to be contracting westwards on the English coast (e.g. *Jujubinus* spp.) are still common on the French coast. Obtaining offshore data presents a problem in that fewer organisations now collect data for research purposes and surveys such as those carried out in the 1960's by Plymouth Marine Laboratory are a thing of the past. It is hoped that links can be developed with commercial fishing boats to get such data, and also that this Society will promote systematic dredging work.

Contact has been established with most of the British organisations who collect marine mollusc data from the DOMMIC area in order to obtain offshore records. Contact and liaison with French laboratories and organisations are also being developed in the hope of encouraging continental malacologists and marine biologists to participate in the DOMMIC project. Data from marine recording cards for the Channel are being incorporated into a dedicated computerised mapping database. It is the target to produce a

provisional Atlas for the Channel by the year 2000.

Late in the year I received details of a noteworthy find at Hannafore Point in Cornwall. Jon Makeham, a member of the British Marine Life Study Society reported the occurrence of a single individual of the Mediterranean species, *Tylodina perversa* (Gmelin, 1791). This pleurobranchiate opisthobranch is highly distinctive having a vivid yellow body with a conical limpet-like external shell which is covered with a coarse shagreen-effect periostracum. (It is illustrated in the new Collins *Pocket Guide to the Seashore* published by Harper Collins, 1996.) The record has been authenticated by Bernard Picton and I would encourage members to keep an eye out for this and other

potential immigrants to our southern coasts.

Marine recording is still the focus of active interest in the Society but for a very small percentage of members and I would like to reiterate past pleas for involvement by more of the membership. A number of Sea Areas are not adequately serviced and there is scope for participation which goes beyond the simple submission of records, valued as that is. Molluscan mapping is a rewarding and stimulating activity and helps to make sense of distribution patterns. It is one thing to find material on strandlines or scattered on the shore - and this has been the source of valuable records for minute rarities, notably submitted by J E Phorson. However, it is important that we should be able to locate the living animals and use the acquired information to find the species in appropriate habitat elsewhere. As always, I thank those who have submitted records during the year.

#### REPORT OF THE HON. CONSERVATION OFFICER

Key items from the 1996–97 year are summarised below:

Biodiversity: The U.K. Steering Group Report: The Environment Agency and English Nature commissioned expanded Species Action Plans for five of the 'short list' species, Anisus vorticulus, Segmentina nitida, Pisidium tenuilineatum, Pseudanodonta

complanata and Vertigo angustior. These were duly produced.

Portland Harbour Revision Order 1996: It was reported in last years Annual Report that Portland Ports Ltd. were trying to gain the management of Portland Harbour. There were widespread concerns that their actions might lead to damaging actions which could endanger the important marine and brackish water Mollusca of Portland Harbour and the adjoining Fleet. Mr. Dennis Seaward represented The Society at the public enquiry, held in September 1996. An outcome is awaited.

Advice and help: Has been given to a wide range of individuals and organisations.

Some of these include:

• Advice given to the R.S.P.B. regarding the management of wetland reserve in East Anglia.

• Further requests for advice from BBONT were dealt with concerning the rare snail,

Vertigo moulinsiana

• The Environment Agency were given advice on river channel maintenance work on a stretch of the River Arun supporting important populations of the Red Data Book species, *Pseudamnicola confusa*.

• The Sussex Wildlife Trust and Friends of the Earth were given information associated with the threats posed to freshwater molluscan populations by water abstraction.

• Advice was suggested regarding the maintenance of a population of *Lymnaea glabra* at a reserve in Cheshire.

•Help was given to a member of Bucks. County Council regarding the presence of

grassland Mollusca on various areas of unimproved chalk grassland.

•Information was provided to help in the production of a regional biodiversity plan for Hampshire and in the production of molluscan details in the 'Going, Going, Gone' publication produced by *The Independent* newspaper and The W.W.F

Molluscan data was provided to Rye Harbour Nature Reserve and The Somerset

Environmental Records Centre.

British Wildlife: The biannual molluscan wildlife report has continued to be produced for this journal. Additionally an article dealing with the conservation of freshwater

molluscs was published in February 1997.

Joint Committee for the Conservation for British Invertebrates: Membership of the Committee continues providing valuable contacts with other organisations. At the time of writing the idea of launching a national invertebrate conservation organisation, 'Buglife' had been suggested and would be discussed by the Society in the coming year. Conservation work undertaken throughout the Society: Many other conservation activities have been undertaken by Society members throughout the year. These are too numerous to mention individually, but range from continued work with the *Partula* breeding programme to the DOMMIC (English Channel) marine molluscan mapping project.

**Publicity**: Members of the Society appeared on regional and national radio and television programmes regarding *Vertigo moulinsiana* on the Newbury Bypass and threats to pearl mussel (*Margaritifera margaritifera*) populations. The Conservation Officer addressed the Sussex Biological Records seminar on the conservation importance of

molluscan mapping.

Conservation Conference: Society members arranged and helped to run the very successful international conference, Molluscan Conservation: A Strategy for the 21st

93

Century. The event, which is described in detail in the Newsletter, was held at the National Museum and Gallery in Cardiff 20–22 November 1996. It is hoped that the Society will be able to run more such valuable events in coming years.

M.J. Willing

#### NEW INSTRUCTIONS FOR AUTHORS

#### GENERAL

The Conchological Society endeavours to publish the Journal of Conchology in the most efficient and cost effective means possible while maintaining high standards of production. Consequently from volume 36 onwards we are moving to maximise the use of electronic page make up.

Contributors are asked to follow these instructions closely. Failure to comply will cause delay and may lead to the return of the manuscript. All papers should be written in clear, concise English. Much material appropriate in doctoral theses is unacceptable for publication. Papers are considered on the understanding that their substance is not already published or offered for publication elsewhere.

Two copies of the manuscript should be submitted, typed double spaced throughout (including references, tables and legends) and authors should retain a copy of the complete manuscript. Authors are also encouraged to submit manuscripts on 3.5" diskettes in any common word processing format, noting that the Journal uses Word for Macintosh and Quark Xpress but can translate most PC files. Transfer of manuscript text via E-mail is also available.

#### Copyright

It is a condition of publication in the Journal that authors assign copyright to the Journal of Conchology. This ensures that requests from third parties to reproduce articles or figures are handled consistently and will also allow the article to be as widely disseminated as possible. In assigning copyright Authors may use their own material in other publications provided that the Journal is acknowledged as the original place of publication

FORMAT OF MANUSCRIPT

Usable Page Size is 135 x 195mm

Text Style

In order to give clear readability the punctuation of the text has been simplified. Authors are asked to pay close attention to the new style.

Paper title in All Caps, Centred

A 'running title' (head) of about 50 characters including spaces

Authors in Small Caps, Centred

Authors address as a footnote

Abstract

Key words no more than five

Section headings in All Caps, Bold, Centred

Subsection headings in Small Caps, Centred

Side headings in Italic followed by 1 em space

Taxonomic descriptions should follow the special instructions outlined below.

NB The Journal will not accept descriptions of new species or subspecific taxa unless the primary type material is deposited in a public or institutional museum and carries a unique identity number. Descriptions of new taxa and taxonomic revisions must comply with the International Code of Zoological Nomenclature.

Sequence for systematic descriptions in the Journal of Conchology

Genus *Semele*Schumacher, 1817 Type species *Semele reticulata* Schumacher, 1817

Definition Text Comparisons or Remarks Text

Semele semele Brown, 1890

(Reference to original description)

Semele semele Brown, 1890: 341, pl. 1, fig. 1

(References to subsequent citations and synonymy)

Tellina vulgaris Smith, 1910: 23

Semele semele Brown-Jones 1940: 87

Semele communis non Green, 1915-Black 1950: 45

(Data on type material)

Holotype 1 sh, off Cape Beach, Cape County, Cape Country, 23°N33°E, 5m, ex. coll Brown, 23 xi 1997, Museum number 1950.12.12.

Paratype as Holotype

Type locality Text

Material examined Text.

Authors are reminded that large quantities of data here may be curtailed and should therefore be summarised. Sequence of data should follow sequence given for holotype as appropriate. Live collected specimens as sp, complete dead shells as sh, single valves of bivalves as v, and fragments as fg.

Measurements Text.

Except for type material measurements of other material examined should be summarised noting number of specimens measured, mean and range.

Diagnosis Text (If appropriate)

Description Text

Derivation of name crassicosta from the Latin crassus, thick and costa, rib; referring to the heavy radial ribs.

Habitat Text

Geographic range Text

Comparisons Text

Remarks Text

#### REFERENCE STYLE

## Authors should note that the Journal is using full citations of journal titles

References are listed alphabetically.

BERNARD F.R., CAI Y.Y. & MORTON B. 1993 Catalogue of the Living Marine Bivalve Molluscs of China Hong Kong University Press, Hong Kong, 146pp.

OLIVER P.G. 1995 Bivalvia. In *Seashells of Eastern Arabia* (S.P. Dance ed) 194–281 Motivate, Dubai. OLIVER P.G. & CHESNEY H.C.G. 1994 New species of shells from Oman *Journal of Conchology* **35:** 56–75.

Runnegar B. & Pojeta J. 1985 Origin and diversification of the Mollusca. In *The Mollusca* 10: *Evolution* (E. R. Trueman & M.R. Clarke eds) 1–57 Academic Press, London.

In text references should take one of the following forms: 'Oliver (1995) said...' or '... (Oliver,

1995)...' or '...(Runnegar & Pojeta, 1985; Oliver, 1995)...'. Avoid *loc cit*.. The first time a paper with multiple authorship is referred to give all the authors' names, thereafter use the form of X *et al.*. References are listed alphabetically.

#### TABLES & ART WORK

Tables invariably have to be type set in order to fit Journal page size. Authors are asked to submit these with their word processed document or in Tab delineated text format. Tables are numbered sequentially and legends should be appended.

Line art should be submitted as high quality originals and care should be taken with dimensions so that reductions are proportionate to the Journal page size which is 135 x 195mm. Text on the art work should be in a sans seraph font preferably Helvetica and should be of a size proportionate for the final reduction.

Maps and graphs can be difficult to scan and should be of fine quality. If these are made electronically on mapping or graphing software these should also be submitted on diskette.

Production of plates is normally in halftone but colour can be published if supported by a grant from the authors. Halftone plates should be of high quality with evenly toned backgrounds. They should be proportionate to the page size and lettering should be in a sans seraph font preferably Helvetica. Colour work can be submitted for halftone production.

All line art and halftones are numbered sequentially using either numbers alone or a combination of numbers and letters Fig. 1 or Figs 1–3 or Figs 1a–f. Legends should be appended with the text.

#### **PROOFS**

The text of the paper must be ready for publication when submitted. One set of proofs will be sent; it is assumed that only printer's errors and factual mistakes will be corrected. More extensive alterations will be charged to the author.

#### REPRINTS

The Journal offers the senior author 25 reprints free of charge, additional copies are charged on a per page basis. Costs at time of press are listed below but these are dependant on printers charges and should be confirmed before placing an order.

#### FORMAT OF COMMUNICATIONS

Manuscripts submitted to this section of the Journal are intended to be short, informative notes of an original nature which do not merit the treatment of a full paper. Contributions which enhance knowledge of the British Isles fauna, distributions and habitats; or those from students and members are especially welcome. Communications may only exceptionally contain tables, line art or half-tones. Reference style is in the form of superscript numbers within the text and short titles as a list at the end of the text.

#### For example

<sup>1</sup>Boycott A.E. 1934 *J. Ecol.* **22**: 1-38.

<sup>2</sup>Cameron R.A.D. 1973 *Malacologia* 14: 355–370

### **INSTRUCTIONS TO AUTHORS**

Manuscripts should be sent to:

THE HON. EDITOR, DR P.G. OLIVER,
NATIONAL MUSEUMS & GALLERIES OF WALES, CATHAYS PARK, CARDIFF CF1 3NP.
GRAHAM.OLIVER@NMGW.AC.UK

Papers Two copies of text and illustrations should be submitted; one set of illustrations must be good quality originals. Authors should refer to *New Instructions to Authors* in this issue as a guide to format. Authors are reminded of the high cost of printing and therefore are expected to write concisely and to make maximum use of page size when designing artwork and tables.

COMMUNICATIONS These are intended to be short notes of an original nature which do not merit the treatment of a full paper. *Communications* do not normally contain any figures, tables or plates and should conform in style to that of recent issues of the *Journal*.

## Journal of Conchology

Vol. 36, No. 1, December 1997

## Contents

	PAG.
PAPERS	
GLOVER E.A. & TAYLOR J.D. New species and records of <i>Rastafaria</i> and <i>Megaxinus</i> (Bivalvia: Lucinidae) from the western Indian Ocean and Red Sea, with a reappraisal of <i>Megaxinus</i> .	1
WARDHAUGH A.A. The terrestrial molluscan fauna of some woodlands in north east Yorkshire England: A framework for quality scoring and association with old woodland flora.	19
HAUSDORF B. Revision of <i>Elia (Acroeuxina)</i> O. Boettger, 1877 (Gastropoda: Clausilidae).	31
SIMONE L.R.L. A new species of <i>Ammonicera</i> (Omalogyridae, Allogastropoda) from Brazil.	43
OLIVER P.G. & CHESNEY H.C.G. Taxonomy and descritions of bivalves (Lucinoidea, Galeommatoidea, Carditoidea, Cardoidea, Tellinoidea & Myoidea) from the Arabian Sea.	51
Communications	
VERDCOURT B. Note on <i>Potadoma ganahli</i> Connolly, 1930 (Prosobranchia, Viviparidae).	77
GAINEY P.A. & TURK S.M. More records of <i>Charonia lampas</i> (L.), a recent record of <i>Pteria hirundo</i> (L.) and a marine slug <i>Tylodina perversa</i> Gmelin new to Britain.	78
RUEDA J. & SALAS C. <i>Modiolus lulat</i> (Dautzenberg, 1891): A tropical west African bivalve recorded from south European coasts.	80
TREGO K.D.  An offshore habitat for an Easter Island bivalve.	81
On the occurence of <i>Maurea waikenae</i> Oliver, 1926 (Gastropoda: Trochidae). A southern range extension for an American west coast Buccinid. The first black abalone hybrid in natural populations.	
Reviews	83
Obituary	86
Corrigenda	87
Proceedings	88
New Instructions to authors	94



(Established 1874)

Vol 36, No. 2, June 1998

onchological Society of

Great Britain and Ireland

# CONCHOLOGICAL SOCIETY OF GREAT BRITAIN AND IRELAND

Registered Charity No. 208205

HON. SECRETARY Ms. J. Reynolds, 21c Loraine Road, Holloway, London N7 6EZ

Hon. Treasurer Ms. A.J. Trew, National Museums & Galleries of Wales, Cathays Park, Cardiff CF1 3NP

Hon. Membership Secretary M.D. Weideli, 35 Bartlemy Road, Newbury, Berks. RG14 6LD

HON. EDITOR Dr P.G. Oliver,
National Museums & Galleries of Wales, Cathays Park,
Cardiff CF1 3NP

HON. CONSERVATION OFFICER Dr M.J. Willing, 14 Goodwood Close, Midhurst, Sussex GU29 9JG

Hon. Marine Census Recorder Mrs J. Light, 88 Peperharow Road, Godalming, Guildford, Surrey GU7 2PN

Hon. Non-marine Census Recorder Dr M.P. Kerney, Department of Zoology, Natural History Museum, Cromwell Road, London SW7 5BD

HON. NEWSLETTER EDITOR Miss R.E. Hill, 447B Wokingham Road, Earley, Reading RG6 7EL

Member's subscription £23 per annum. Entrance fee £1.

FAMILY MEMBERSHIP £25 per annum.

Institutional membership £32 (UK rate); £37 (overseas\*) per annum.

STUDENT MEMBERSHIP £10 per annum.

\*Overseas members are reminded that all fees due to the Society are payable in pounds sterling.

Publications Members receive:

The Journal of Conchology (usually two numbers a year)

The Conchologists' Newsletter (quarterly)

For back-numbers of these publications and special numbers please apply to: Mr M.D. Weideli, 35 Bartlemy Road, Newbury, Berks. RG14 6LD.

MEETINGS There are six indoor meetings per year between October and May, usually held at the Natural History Museum. Field meetings, workshops and other events are held throughout the year at various locations.

© Conchological Society of Great Britain and Ireland Printed by Henry Ling, The Dorset Press, Dorchester DT1 1HD



# A NEW GENUS AND SPECIES OF FRESHWATER PULMONATE (PLANORBIDAE) FROM KENYA

D.S. Brown<sup>1</sup> & B. Verdcourt<sup>2</sup>

Abstract The shell and radula are described of Theratodocion kibokoense n. gen., n. sp. (Gastropoda, Pulmonata; family Planorbidae) from eastern Kenya. The new taxon is distinguished from all species of Planorbidae known from Africa and worldwide by its pseudodextral high-spired and nodular shell.

Key words Planorbidae, New Genus, New Species, Freshwater snail, Africa, Kenya.

#### Introduction

In 1991 one of us (BV) received from Mr T.E. Crowley 12 specimens of an apparently undescribed species of pulmonate snail collected by Mr N.J. Peake from the bank of a stream near Hunters' Lodge Hotel in eastern Kenya. All the specimens were dry, but most were in fresh condition, and so we postponed publishing a description in the hope that materials suitable for a full anatomical description might be obtained by some other collector, Mr Peake having left Kenya. Unfortunately we have not received more specimens, but having extracted part of the radula from one of the original examples, we feel that they can be placed with some confidence in the Planorbidae. We hope that this account will encourage search for this distinctive snail and lead to a better knowledge of its morphology, relationships and ecology.

#### Systematic Description

Basommatophora Planorbidae Planorbinae

Genus *Theratodocion* n. gen.

Type species Theratodocion kibokoense n. sp. East Africa, Kenya.

Description A planorbid with a radula having marginal teeth of the long oblique type (Hubendick, 1955); shell small, pseudodextral with stepped spire, globose, nodular.

Derivation of name From the Greek **theratis**, a hunter, and **docheion**, resting place. Formed by analogy with the modern Greek word **xenodocheio**, hotel or resting place for strangers.

Familial placement The lack of operculum, the numerous small teeth in each transverse row and the apparently aquatic habitat indicate that *Theratodocion* is a basommatophoran pulmonate. The radula teeth have the form characteristic of the Planorbidae: central (median) tooth bicuspid, inner lateral teeth tricuspid, outer marginal teeth long and oblique (Hubendick, 1955). The shell is pseudodextral in several groups within the subfamily Planorbinae, but this form is unknown in the Bulininae, the only other subfamily currently recognised.

<sup>&</sup>lt;sup>1</sup>Department of Zoology, The Natural History Museum, Cromwell Road, London SW7 5BD. Fax: 0171 938 9249. E-mail: dsb@mailserver.nhm.ac.uk.

<sup>&</sup>lt;sup>2</sup> Royal Botanic Gardens, Kew, Richmond, Surrey, TW9 3AB.

Comparison with other genera of Planorbidae No similar shell form has been described from the Recent planorbid fauna of Africa and Madagascar. Although the shell is pseudodextral with a low spire in some Afrotropical species within genera which are essentially planispiral (Afrogyrus, Ceratophallus, Gyraulus, Biomphalaria), such spires are much lower than that of Theratodocion, and these shells are not nodular. Outside Africa there occur planorbid genera having pseudodextral shells and a spire of comparable height to Theratodocion, but these differ in various respects: Acrorbis Odhner, 1937, of Brazil, is smooth-shelled and its radula has short, broad marginal teeth (Baker, 1945; Hubendick, 1955); Carinifex Binney, 1863 (treated by Burch, 1980 as a subgenus of Helisoma) of western North America has a shell lacking nodules, usually biangular with a pronounced angle in the basal lip; Choanomphalus Gerstfeldt, 1859 of Lake Baikal is smaller and valvatoid (Baker, 1945; Hubendick, 1954; 1955); Parapholyx Hanna, 1922 (treated by Burch, 1980 as a subgenus of Vorticifex) of western North America is neritoid, with smooth rapidly increasing whorls and expanded lip.

## *Theratodocion kibokoense* n. sp. Figs 1, 2

Holotype 1 shell (BMNH1996157).

*Paratypes* 11 from the type locality: 7 dry (BMNH1996158); 2 in ethanol, one from which the radula was extracted and another having the remains of the body deep within the shell (BMNH1996159); 1 dry (Musée Royal de l'Afrique centrale, Tervuren, registration no. 803.176); and 1 dry (T.E. Crowley collection).

Type locality Kenya, east bank of a tributary stream of the Kiboko River, in the grounds of Hunters' Lodge Hotel, about 150 km SE of Nairobi on the main road to Mombasa; 2° 12′S 37° 43′E approx., 900 m approx. altitude; collector N.J. Peake, 12 Jan 1991. The specimens were collected just south of the hotel building, within an area extending along about 30 m of the bank and from the water's edge to about 20 m from the riverside (see further details under Habitat).

Diagnosis The shell of *Theratodocion kibokoense* differs from those of all other pseudodextral species of the Planorbidae in its comparatively high and stepped spire and coarsely nodular surface.

Description Shell (Fig. 1) pseudodextral; spire about as high as aperture, depressed above with apex involute, sides stepped; narrowly though distinctly umbilicate, rather solid. Whorls to nearly 3.5 (holotype), rapidly increasing, the third and fourth irregularly transversely ribbed and with three thick nodular ridges, bluntly angled above and below. On most of the fourth and the third whorl the nodular ridges are separated by two spiral furrows. Sculpture of initial whorl not determinable due to erosion, about 20 ribs per mm at beginning of third whorl and 10 per mm on fourth whorl. Umbilicus surrounded by a low ridge continuing on the parietal surface within the aperture. Aperture oblique, receding at base, with outer lip at about 45 degrees to the vertical, sub-circular, with obtuse angles corresponding to the spiral ridges. Lip thin and continuous, with narrow columellar reflection. Colour probably chestnut brown when fresh; where unworn the surface is glossy and translucent with an opalescent sheen in parts.

Measurements of holotype (the largest shell): height 6.1 mm, breadth 5.7 mm, whorls 3.4. Smallest paratype: height 4.4 mm, breadth 5.3 mm, whorls 3.0.

Radula ribbon 0.5 mm wide and at least 1.33 mm long (anterior end damaged); formula 261-26, transverse rows curved towards the margins (Fig. 2). Central tooth

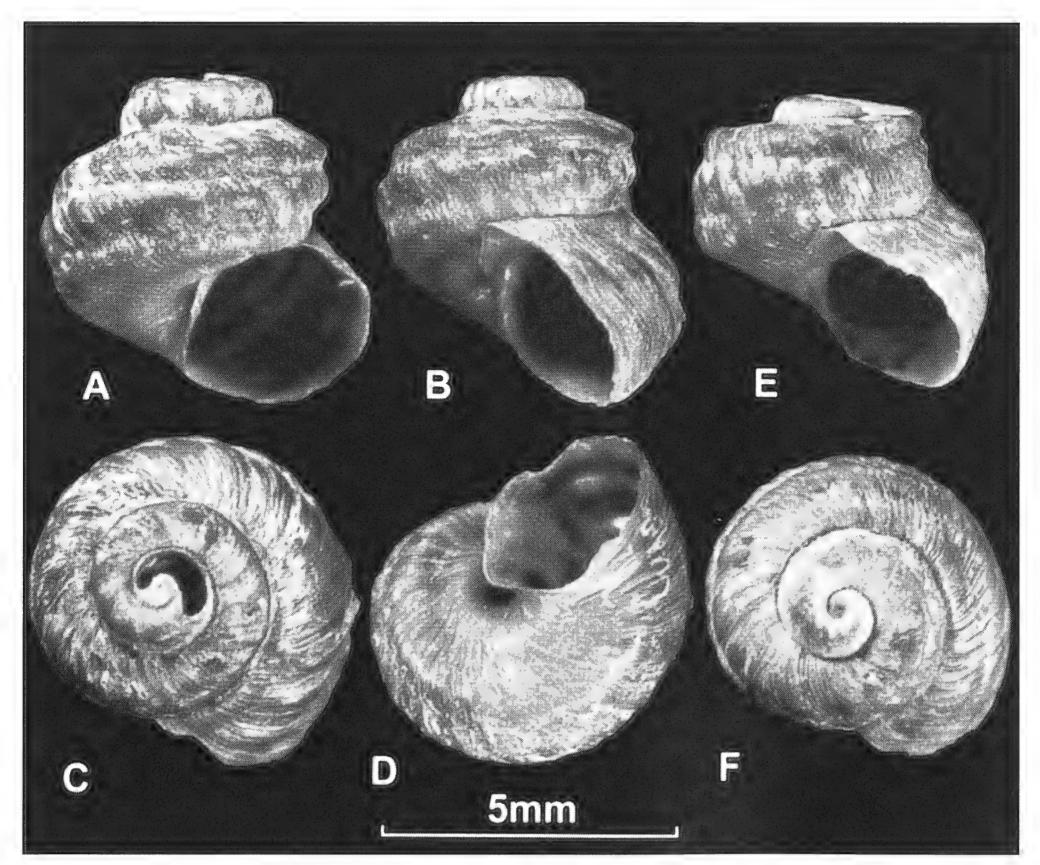
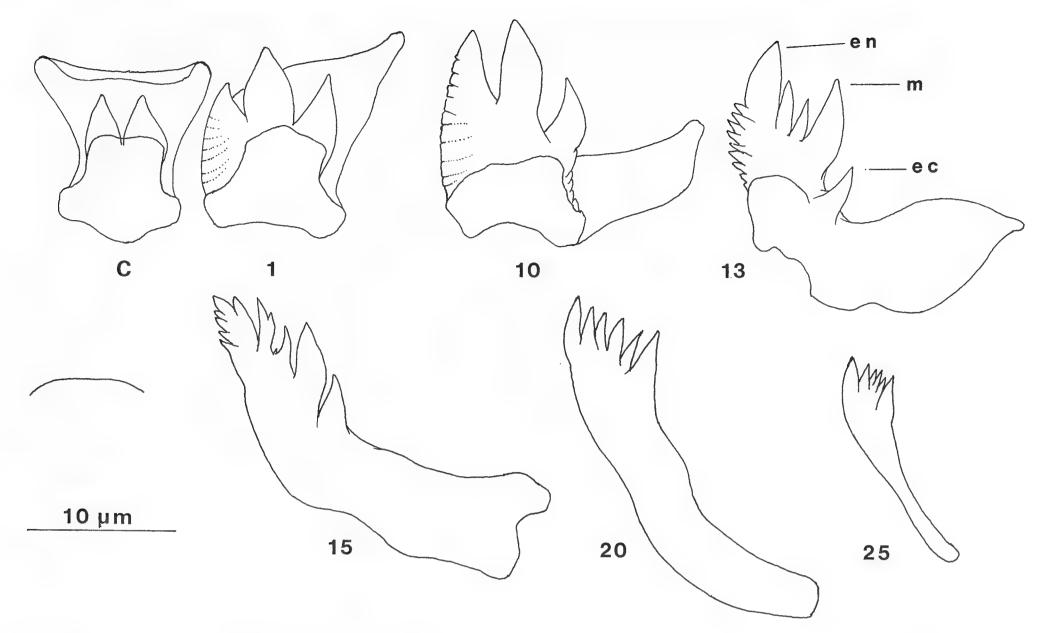


Fig. 1 Shells of *Theratodocion kibokoense* n. gen., n. sp. A–D, holotype. E, F, paratype.

bicuspid, with pointed cusps, lacking any interstitial denticle. First lateral teeth tricuspid, cusps pointed; mesocone sides curved or subanglar, endocone with median side fluted and about same size as ectocone. In subsequent lateral teeth the endocone increases in size, becoming by tooth 10 larger than both the ectocone and mesocone. In tooth 13 there are small denticles along the median side of the endocone, additional cusps are present between the endocone and mesocone, the ectocone is comparatively small and the whole tooth rather elongate. Further towards the margin the teeth become progressively more elongate and the ectocone becomes obsolete. Although transition in tooth form is continuous, the teeth from 20 outwards are distinguishable as marginals, being slender and aligned obliquely to the longitudinal axis of the radula.

Derivation of name From Kiboko River; kiboko in Swahili meaning hippopotamus.

Habitat It is not known exactly where *Theratodocion kibokoense* was found within the area of the collecting site. The specimens were pooled with other aquatic molluscs obtained at the same time: *Bellamya unicolor* (Olivier), *Melanoides tuberculata* (Müller), *Lymnaea natalensis* Krauss, *Gyraulus costulatus* (Krauss), *Biomphalaria pfeifferi* (Krauss), *Bulinus* cf. *natalensis* (Küster) and *Corbicula africana* (Krauss). This entire collection was taken from an area of about 600 m²; specimens were collected in the stream from just below the water level and on the bank up to about 35 cm above the water, where they could have been deposited by flood water (N.J. Peake, *in litt*. to Brown, 4 Dec 1996).



**Fig. 2** Radula teeth of *Theratodocion kibokoense* n. gen., n. sp.; drawn to scale by means of eyepiece grid and squared paper. Central tooth (C) and selected teeth from one half of a transverse row, numbered from the central towards the margin (total teeth 26). Each tooth orientated as it lay in relation to the central tooth, the cusps pointing towards the nascent end of the radula. The curved line at the left of the figure represents the shape of one complete transverse row of teeth. m, mesocone; ec, ectocone; en, endocone.

The stream where *Theratodocion kibokoense* was found arises at springs situated a few hundred metres south of the Hunters' Lodge Hotel, flows past the hotel and joins the Kiboko River about 6 km to the north east. The Kiboko is a small river and its flow varies widely according to season and from one year to another; the stream has a comparatively constant flow. Within the collecting site the water was impounded by a weir situated downstream, forming a pool about 15 m wide. The eastern bank where the specimens were collected was kept clear of high vegetation, though there were a few short rushes at the water's edge. The opposite bank was lined with papyrus and mature *Acacia* trees at intervals. Water clear; substratum of shallow organic mud over stones. *Tilapia* and probably also catfish and barbel were present.

Geographic range Known only from the type locality.

### **DISCUSSION**

It is surprising that so distinctive a species new to science should be found in a locality that has received considerable attention from collectors of aquatic snails. However, in this eastern region of Kenya the rainfall is fairly low (averaging about 600 mm per year) and a number of endemic or near endemic species of aquatic snail are known from single or only a few localities (Brown, 1980; 1994, e.g. the prosobranchs *Gabbiella verd-courti* Mandahl-Barth, *G. parvipila* (Verdcourt), *Incertihydrobia teesdalei* Verdcourt, *Eussoia inopina* Preston, *Cleopatra athiensis* Verdcourt). Some of these snails' habitats are refuges

5

persisting through the dry season because they are fed by perennial springs. The springs near the Hunters' Lodge Hotel support the only known living population of *E. inopina*. Since a considerable amount of collecting activity by ourselves and others had not previously revealed the presence of *Theratodocion*, in the spring, stream or pools, this snail appears to inhabit a specialised and restricted niche, from where specimens could have been carried by flood water to the collecting site.

The subfamily Planorbinae is basically planispiral, and the development of a distinct spire, most common in the pseudodextral form, is usually associated with lakes, e.g. *Carinifex*, *Choanomphalus*, *Parapholyx* and certain species of *Gyraulus* which are endemic to Lake Ochrid or to Lake Biwa in Japan (Meier-Brook, 1983). Occasionally, however, a markedly pseudodextral form is found in different conditions, such as *Acrorbis* in damp moss on rocks over which water trickled (Odhner, 1937) and *Gyraulus crenophilus* Hubendick & Radoman on stones in small creeks arising from nearby springs (Hubendick & Radoman, 1959).

We hope that this report will stimulate search for the habitat of *Theratodocion* and the collection of the materials needed for a comprehensive assessment of its relationships with other genera of Planorbidae.

### **ACKNOWLEDGEMENTS**

We are indebted to Messrs N.J. Peake and T.E. Crowley for the privilege of studying this remarkable addition to the aquatic pulmonate fauna of Africa. The description of the collecting site is based on notes kindly supplied by Mr Peake and Professor G.K. Kinoti. We thank Harry Taylor (The Natural History Museum; Photographic Unit) for his careful skill in producing the images of shells.

### REFERENCES

- BAKER F.C. 1945 The molluscan family Planorbidae Urbana, University of Illinois Press.
- Brown D.S. 1980 Freshwater snails of Africa and their medical importance London, Taylor & Francis.
- Brown D.S. 1994 Freshwater snails of Africa and their medical importance (2nd edition) London, Taylor & Francis.
- Burch J.B. 1980 North American freshwater snails. Species list, ranges and illustrations *Walkerana* **1(3)**: 81–215.
- Burch J.B. 1982 North American freshwater snails. Identification keys, generic synonymy, supplemental notes, glossary, references, index *Walkerana* **1 (4)**: 217–365.
- HUBENDICK B. 1954 On the anatomy of *Choanomphalus* (Moll. Pulm.) *Arkiv för Zoologi, Stockholm* **6**: 503–509.
- Hubendick B. 1955 Phylogeny in the Planorbidae *Transactions of the Zoological Society, London* **28**: 453–542.
- Hubendick B. & Radoman P. 1959 Studies on the *Gyraulus* species of Lake Ochrid. Morphology *Arkiv för Zoologi, Stockholm, series* 2, **12**: 223–243.
- MEIER-Brook C. 1983 Taxonomic studies on *Gyraulus* (Gastropoda: Planorbidae) *Malacologia* **24**: 1–113.
- ODHNER N.H. 1937 *Acrorbis petricola*, n. gen., n. sp., eine merkliche Süsswasser-Schnecke aus Brasilien *Arkiv för Zoologi*, *Stockholm* **29B (14)**: 1–8.

	,	

## OBSERVATIONS ON ONOBA SEMICOSTATA AND O. ACULEUS AROUND BRITISH AND NORTHERN FRENCH COASTS

I.J. KILLEEN<sup>1</sup> & J.M. LIGHT<sup>2</sup>

Abstract Confusion over the distributional ranges and the identity of the rissoids Onoba semicostata and O. aculeus has led to the latter being under-recorded. Systematic fieldwork over the last 10 years has shown that O. aculeus is widespread around the British Isles and on the northern coast of France. This paper gives additional information on the distribution, ecology and location of the Onoba species.

Key words Gastropoda, Rissoids, Biogeography, Britain, France.

### Introduction

Distributional information published in malacological journals, distribution atlases and molluscan literature in general can act as a useful guide to identification. However, it is unwise to allow this information to limit one's thinking and judgement. Species are regularly found to turn up outside their hitherto recognised geographical range and sometimes it is necessary to rethink and completely revise the distributional pattern of certain taxa. In the north-east Atlantic this is particularly true for the two rissoids, *Onoba semicostata* (Montagu, 1803) and *O. aculeus* (Gould, 1841).

At present *Onoba aculeus* is cited in British literature as a northern species whereas *O. semicostata* is widespread. This opinion can be traced from Jeffreys (1862–9) to McMillan (1968), and Seaward (1982) gives maps which reinforce the accepted view. Hints that the difference in distribution may not be so clearcut appear in Smith (1978), Biekart (1983), Van Aartsen *et al.* (1984), Barnes (1985), Graham (1988) and Seaward (1990). Smith (1978) recognised specimens of *O. aculeus* from the east coast of Ireland and the Isle of Man, and Barnes (1985) had found the species in a saline lagoon at Shingle Street, Suffolk. In 1987, one of us (JML) examined specimens with similar shell characters from a lagoon at Pagham, Sussex. These were also examined by Dr Vera Fretter who thought that some of the specimens were indeed *O. aculeus*.

Around the same time we started systematic shore surveys in Marine Sea Area Wight (S15) and around the Isle of Wight. Specimens of *Onoba* lacking the distinctive features of *O. semicostata* and closely resembling Shingle Street and Pagham material occurred frequently at many of our sites, often in samples with *O. semicostata*. The Conchological Society's field trip to the west coast of Ireland in 1988 also provided specimens from most sites that could be assigned to *O. aculeus*. It became clear that the actual distribution of *O. aculeus* might be much more widespread than the literature indicated. How did this situation come about? It is unlikely that *O. aculeus* had spread rapidly into southern waters during the last century and it suggests a failure to recognise the distinction between the two species, perhaps brought about by accepted geographical distributions.

### SHELL MORPHOLOGY

Graham (1988) gives descriptions and figures of the 2 species and Warén (1996) gives several SEMs. It is not appropriate to give a synthesis of published descriptions here.

<sup>&</sup>lt;sup>1</sup> 163 High Road West, Felixstowe, Suffolk, IP11 9BD, UK.

<sup>&</sup>lt;sup>2</sup> 88 Peperharow Road, Godalming, Surrey, GU7 2PN, UK.

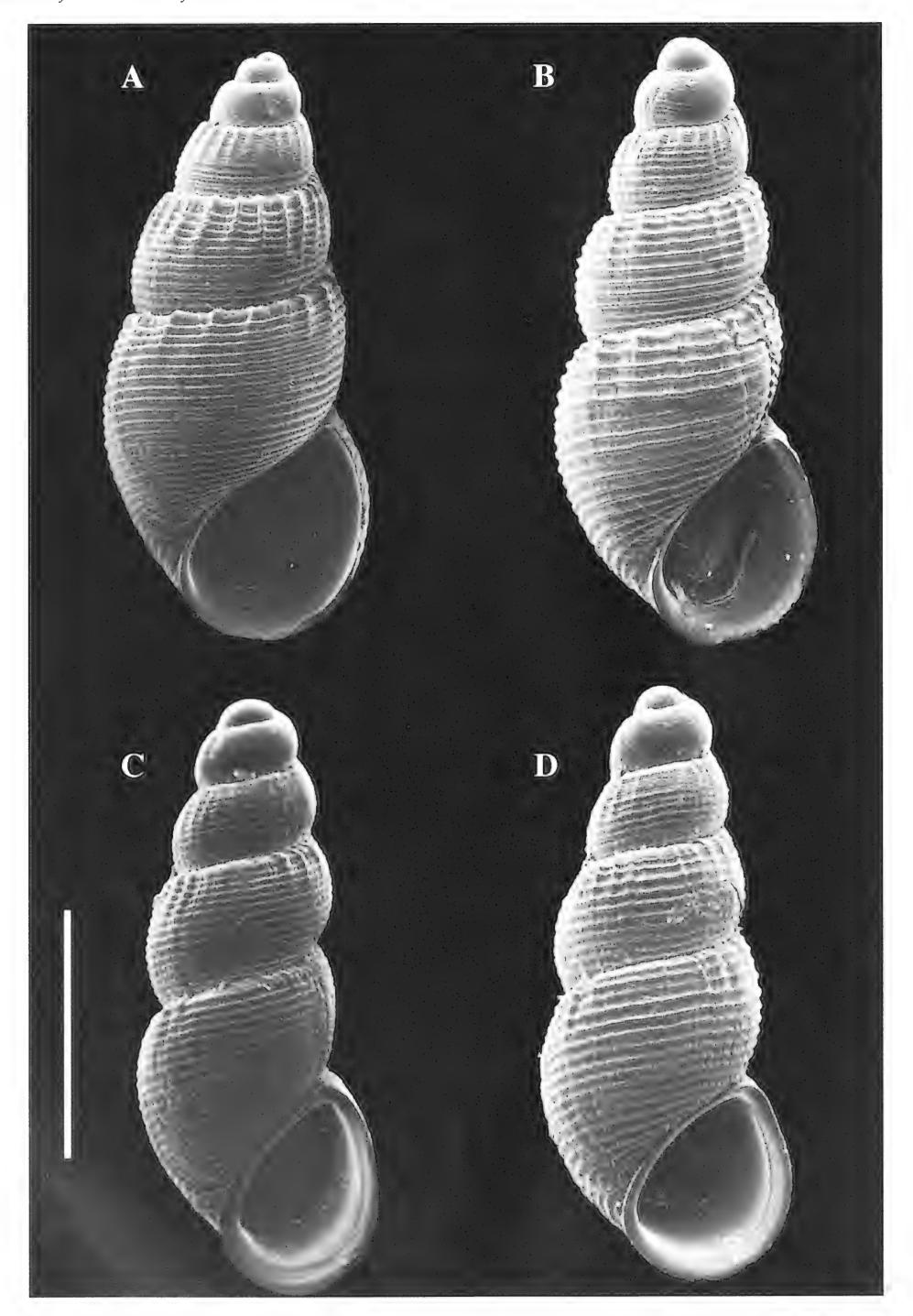
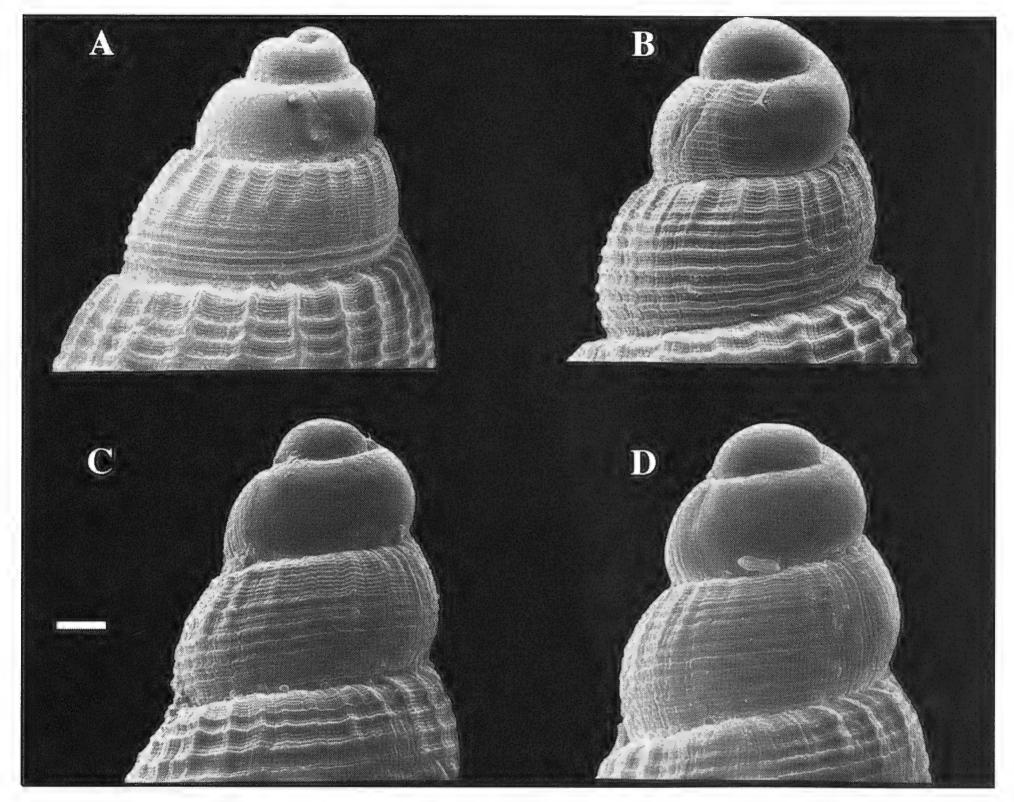


Fig. 1 A Onoba semicostata Murles Point, Co. Donegal, Ireland. B-D O. aculeus. B Murles Point, Co. Donegal, Ireland. C lagoon, Shingle Street, Suffolk, England. D lagoon, Pagham, Sussex, England. Scale bar = 1 mm.



**Fig. 2** *Onoba* protoconchs. **A** *Onoba semicostata* Murles Point, Co. Donegal, Ireland. **B–D** *O. aculeus.* **B** Murles Point, Co. Donegal, Ireland. **C** lagoon, Shingle Street, Suffolk, England. **D** lagoon, Pagham, Sussex, England. Scale bar =  $100 \mu m$ .

However, to distinguish between the two species we consider the key diagnostic characters to be: protoconch diameter (narrow in *O. semicostata* giving a more pointed appearance, Figures 1A & 2A, and broad in *O. aculeus*, Figures 1B–D & 2B–D); the less conspicuous costae of *O. aculeus*, and on which species are frequently absent from the body whorl, but nearly always present, particularly on the upper whorls of *O. semicostata*, Figure 1A & 2A; the presence of brown banding which is usually found only on *O. semicostata*; and deeper sutures on *O. aculeus* giving the appearance of a more loosely coiled shell, Figures 1B–D. Distorted specimens of *O. semicostata* occur frequently where parasitism produces large bent shells. In common with many rissoid species, inter- and intra-population variability in adult shell size and shape occurs. Warén (1973) figures a number of varieties of shell shape for *O. aculeus*.

### **E**COLOGY

Based on our experience of sampling shores along the southern coast of England, north coast of France, western Ireland and Scotland, and other localities around the British Isles, we have made the following observations on the species' ecology:

Collecting samples of weeds or epifauna from rocks frequently results in the gathering of both species of *Onoba*. However, in general the two species have different habitat

requirements. *Onoba aculeus* lives on red and green algal species from relatively high on the shore and into the shallow sublittoral. We have rarely encountered it in depths greater than 20 m. It is tolerant of reduced salinity, being found in lagoons where there is tidal percolation such as The Fleet and Shingle Street. Warén (1996) also records it from brackish water in Scandinavia. It is also found under rocks around High Water Mark in association with the pulmonate *Leucophytia bidentata* (Montagu, 1803).

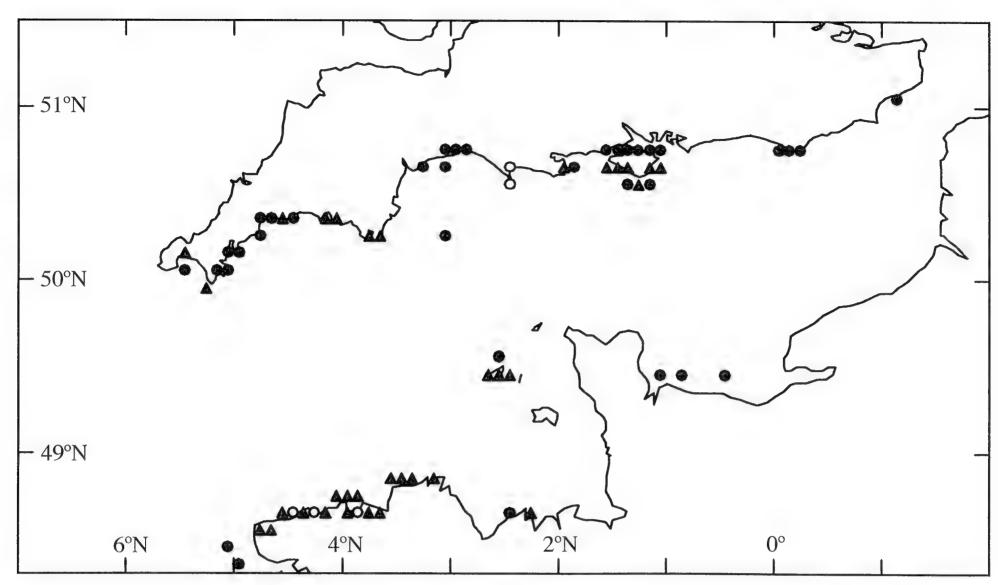
Onoba semicostata is found from low on the shore to depths greater than 100 m. It is more usually associated with sediment rather than weeds. Although it is frequently retrieved from weedwashing samples, these samples are usually derived from weeds with holdfasts, such as Corallina officinalis, that entrap sediment. On the shore, large numbers of specimens of O. semicostata can be found in the layer of silt that coats small stones beneath larger rocks, frequently in association with Alvania semistriata (Montagu, 1803). Sublittorally it is found in shelly sediments and gravels especially those with a silty element. Warén (1996) gives depths to 40 m whereas Graham (1988) gives 100 m. Sublittoral sampling by ourselves in the Firth of Lorn, west Scotland has yielded specimens at depths up to 75 m. However, during a major benthic survey of the Irish Sea (Mackie et al. 1995), O. semicostata was frequently recorded in St Georges Channel at depths up to 132 m.

### DISTRIBUTION

Warén (1996) gives the distribution of Onoba semicostata from northern Norway and northern Iceland, the Faeroes and south to Mediterranean Spain (Algeciras). It has been recorded at sites all around the British Isles. For Onoba aculeus, Warén (1996) gives a distribution of Arctic, south to New England and north-western Spain. He records it as common in Iceland, the Faeroes, the Skagerrak, the Kattegat, and the southernmost Baltic. For British waters data given in Seaward (1990) included records from southern localities but this did not alter the overall view of O. aculeus as a northern species. Systematic recording by the present authors mainly in England and France in the last 10 years has shown that it has a much wider distribution. O. aculeus has now been found in most coastal Sea Areas around the British Isles although as with many other rissoid species, it is uncommon between the Humber and the Isle of Wight. It is very common along western coasts of Scotland and Ireland and also along the south coast of England from Cornwall to the Isle of Wight. With the launch in 1995 of the project to map the Distribution Of Marine Molluscs In the Channel (DOMMIC) systematic surveying has included the Channel Islands and the Brittany coastline of France. The preliminary results of this work (Figure 3) have shown that O. aculeus is similarly common around Guernsey and Herm, and on the French coast between Portsall (04°43'W) and Pointe de la Latte (02°17′W). Future work will determine if there is a similar east/west boundary as appears to be the case on the English side of the Channel.

### NOTE FOR RECORDERS

With the effort currently directed towards the DOMMIC Channel Atlas project we are keen to ensure that the data submitted are based on accurate identifications. The recent work has shown that *Onoba aculeus* is common on coasts on both sides of the Channel. Please examine *Onoba* samples carefully and expect that *O. aculeus* is as likely to be present as is *O. semicostata*. Any member needing help with identification of the 2 species is invited to send a sample which they suspect might contain a mixture, and a representative sample of each species will be separated out.



**Fig. 3** Post 1987 records of *Onoba* species in the channel.  $\bullet = O$ . *semicostata* O = O. *aculeus*  $\blacktriangle =$ both species.

### **ACKNOWLEDGEMENTS**

We are grateful to Dr Richard Preece and staff at the Department of Zoology, University of Cambridge for the Scanning Electron Photomicrographs.

### REFERENCES

AARTSEN J.J. VAN, MENKHORST H.P.M.G. & GITTENBERGER E. 1984 The marine Mollusca of the Bay of Algeciras, Spain, with general notes on *Mitrella*, Marginellidae and Turridae *Basteria* Supplement 2: 1–135.

BARNES R.S.K. 1985 The coastal lagoons of East Anglia UK *Nature Conservancy Council. CSD Report* No. 600.

BIEKART J.W. 1983 A note on the distribution of Onoba aculeus (Gould 1841) Basteria 47: 54.

Graham A. 1988 Molluscs: Prosobranch and pyramidellid gastropods *Synopses of the British Fauna (NS) No. 2 (second edition)* E.J. Brill/Dr W. Backhuys, Leiden.

Jeffreys J.G. 1862–9 British Conchology Van Voorst, London.

Mackie A.S.Y, Oliver P.G. & Rees E.I.S. 1995 Benthic biodiversity in the southern Irish Sea. *Studies in marine biodiversity and systematics from the National Museum of Wales. BIOMÔR Reports* 1: 263 pp.

McMillan N.F. 1968 British Shells Warne, London.

SEAWARD D.R. 1982 Sea Area Atlas of the marine molluscs of Britain and Ireland Nature Conservancy Council, Shrewsbury.

SEAWARD D.R. 1990 Distribution of the marine molluscs of north-west Europe Nature Conservancy Council, Peterborough.

SMITH S.M. 1978 On the occurrence of Onoba aculeus (Gould, 1841) in Scotland and Ireland

### 12 I.J. KILLEEN & J.M. LIGHT

(Prosobranchia: Gastropoda) Porcupine Newsletter 1(6): 98.

Warén A. 1973 Revision of the Rissoidae from the Norwegian North Atlantic Expedition *Sarsia* **53**: 1–13.

Warén A. 1996 New and little known Mollusca from Iceland and Scandinavia. Part 3 *Sarsia* 81: 197–245.

## MYTILOPSIS LEUCOPHAETA, (CONRAD, 1831)[BIVALVIA: DREISSENOIDEA]. A SPECIES NEW TO THE BRITISH FAUNA

P.G. OLIVER<sup>1</sup>, A.M. HOLMES<sup>1</sup> & C. METTAM<sup>2</sup>

Abstract Mytilopsis leucophaeta (Conrad, 1831) is recorded for the first time from British waters. It has been found in a brackish dock in south Wales and is associated with other alien taxa.

Key words Mytilopsis leucophaeta, Introduced species, New to British fauna.

### Introduction

The Dreissenoidea or Zebra Mussels are represented by two extant genera; the familiar freshwater *Dreissena* and the generally tropical or subtropical brackish water *Mytilopsis*. *Mytilopsis* species are thought to be primarily Caribbean/Panamic and tropical west African in origin but have spread throughout the world including western Europe (Marelli & Gray, 1983, 1985). One species *M. leucophaeta* was known from Belgium (River Scheldte) as early as 1835 and described under the name of *Mytilus cochleata* Kickx in Nyst, 1835. Since then it has been recorded from the Rhine, Meuse and Scheldte estuaries in the Netherlands (Wolff, 1969; Kelleher, 1997) from the German Rhine, Weser and Nord-Ostsee Kanal (Gloër & Meier-Brook, 1994) from Nieuport in Belgium (Adam, 1960), and from Dunkerque and the Canal maritime de Caen in France (Germain, 1931). Despite the close proximity of the Dutch population this species had not been recorded from the British Isles.

In November, 1996 Dr. Andrew Mackie collected clumps of the serpulid polychaete, *Ficopomatus enigmaticus* (Fauvel 1923), from the walls of Roath Basin, Cardiff Docks in South Wales. Amongst these were specimens of both *Mytilus* and *Mytilopsis*, the latter immediately recognisable by the presence of a thick lamellar periostracum.

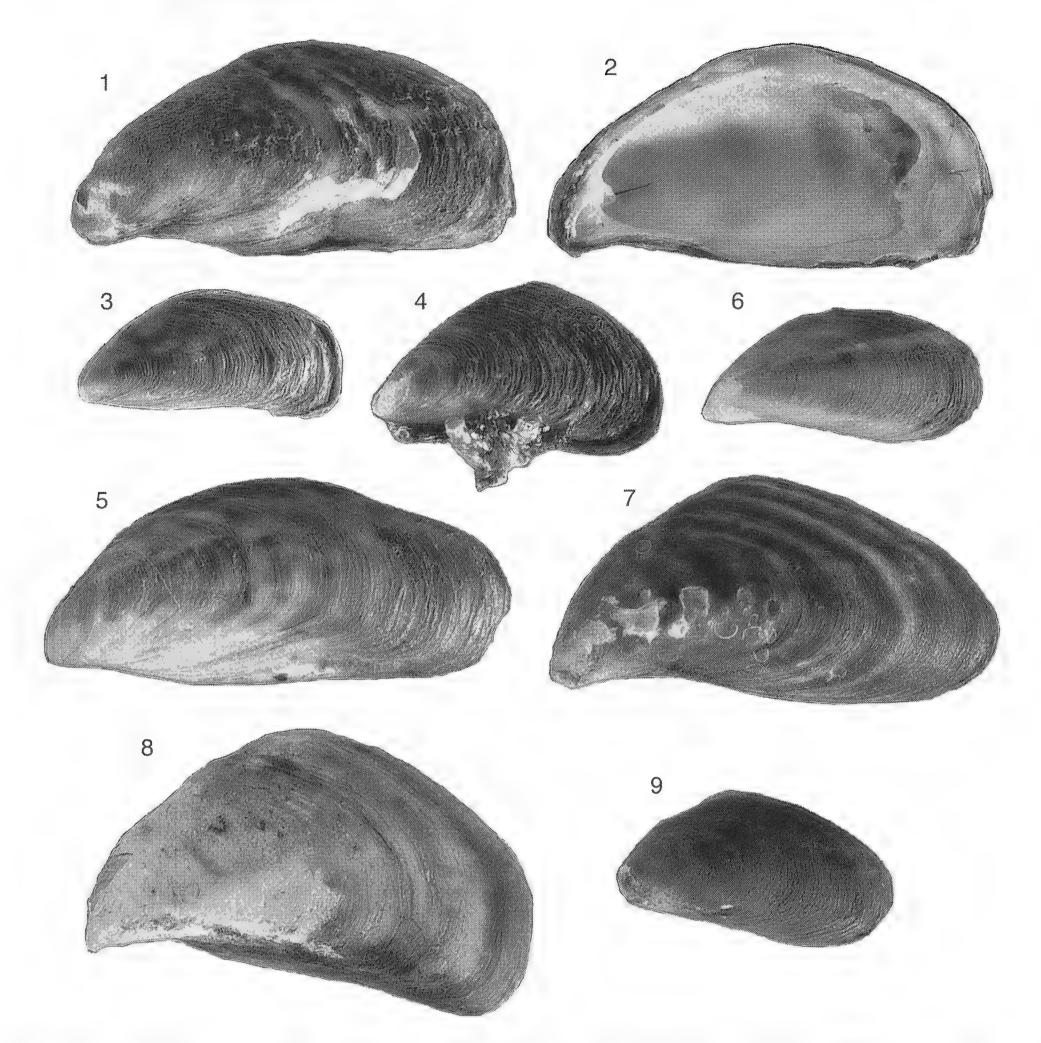
### **IDENTIFICATION**

Mytilopsis species, as with many mytiliform bivalves, are rather variable and have given rise to considerable taxonomic and nomenclatural confusion. Marelli & Gray (1983) revised the West Atlantic species and concluded that only two species were valid, namely M. leucophaeta (Conrad, 1831) (Fig.6) and M. sallei (Récluz, 1849) (Fig.8) and that these species were the only ones to have become aliens elsewhere in the world. Two other species M. africana (van Beneden, 1835) (Fig.7) and M. ornata (Morelet, 1885) (Fig.9) are known from tropical West Africa. Unfortunately Marelli & Gray (1983, 1985) did not comment on the many references (Pilsbry & Bequaert,1927; Adam, 1960; Wolff, 1969) that the European populations originated in West Africa. Marelli & Gray (1985) by inference dismiss the previous possibility by aggregating M. africana and M. sallei in a subgroup separate from M. leucophaeta. The problems of interpreting the origins of alien species are highlighted by the debate carried out by Morton (1981) and Marelli & Gray (1985) over the introduction of Mytilopsis species in the central and Indo-Pacific.

Following Marelli & Gray (1983, 1985) the British specimens would be attributed to

<sup>&</sup>lt;sup>1</sup> Dept. of Zoology, National Museum of Wales, Cardiff, CF1 3NP.

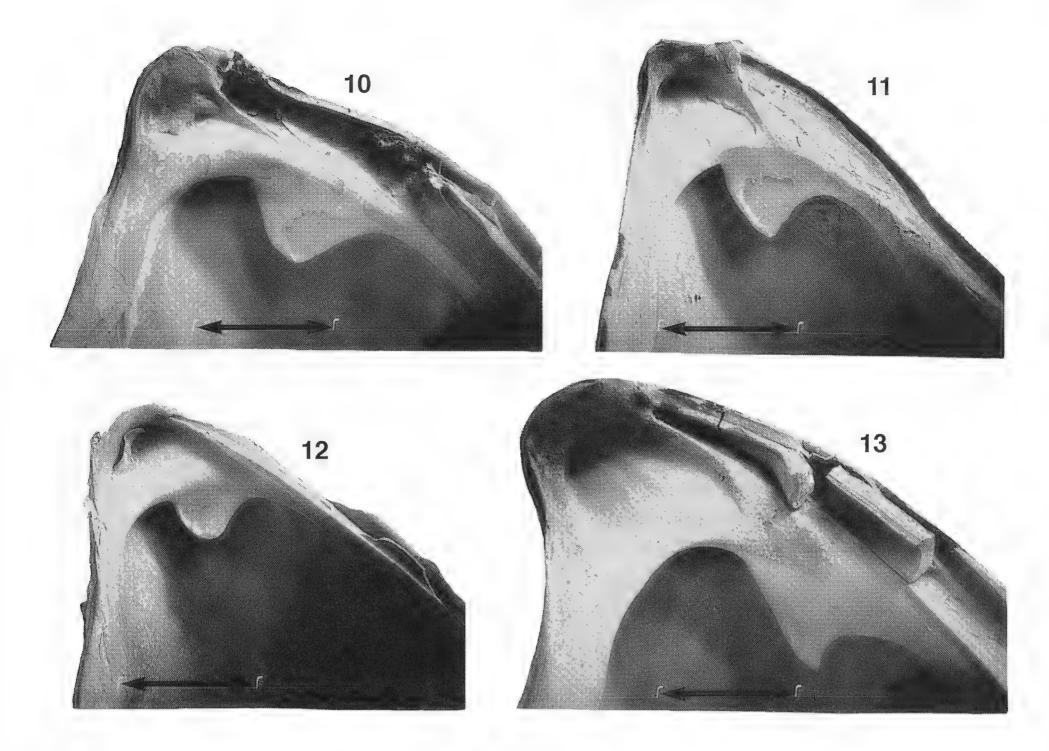
<sup>&</sup>lt;sup>2</sup> PABIO, University of Wales, P.O. Box 915, Cardiff, CF1 3TL, UK.



**Figs 1–6** *Mytilopsis leucophaeta* **Figs 1–4** Roath Basin, Cardiff Bay NMW.Z. 1997.010.1–4 Fig. 5 River Scheldte, Antwerp, Belgium NMW.1955.158.2046 **Fig. 6** Choptank River, Maryland, USA NMW.1955.158.2044 **Fig. 7** *M. africana* Assinie, Ivory Coast, NMW. 1955.158.1249 [is syntype of *D. gibberosa* Preston] **Fig. 8** *M. sallei* Mexico NMW. 1955.158.2047 **Fig. 9** *M. ornata* Congo River, Zaire, NMW. 1955.158.2045. All x2.

M. leucophaeta. However because of the early assertions that the European populations originated in West Africa we examined specimens of all species held in the National Museum of Wales including topotypical material of M. cochleata from the R. Scheldte (and from the Amstel River, Holland (Fig.5)).

Marelli & Gray (1983) distinguish the West Atlantic species on H/W ratio, characters of the apophysis, and disposition of muscle scars. The H/W ratio of the Cardiff population (Figs 1–4, Table 1) encompasses the ranges given for both *M. leucophaeta* and *M. sallei*. This should not be surprising as the shell shape of mytiliform bivalves is notoriously variable and depends greatly on micro habitat and growth rate (Seed, 1992). Our data may not be directly comparable as Marelli & Gray do not indicate the numbers measured at each part of the growth series. Allometric changes may occur at different



**Figs 10–13** Scanning Electron Micrographs of the apophysis and septum in the right valve Fig. 10 *M. leucophaeta* Cardiff, NMW.Z. 1997.010.5 Fig.11 *M. leucophaeta* R. Amstel, NMW.1955.158.2043 Fig.12 *M. leucophaeta* Choptank, USA, NMW. 1955.158.2044 Fig.13 *M. africana* Ivory Coast, NMW. 1955.158. 1249. Scale bar = 1 mm.

sizes especially when a species is living in an alien environment. The Cardiff specimens are rather variable in outline from elongate to hatchet shaped and as with mytilids, shape is not a totally reliable character (Seed, 1992). We therefore turned to the characters of the septum and apophysis (Figs 10–13).

From the material at hand we conclude that the Cardiff specimens are nearest in form to other European specimens bearing the name *M. cochleata*. The orientation, size and shape of the apophysis are identical as are the disposition of muscle scars and general form of the shell. The apophysis characters indicate that the Cardiff specimens are definitely not those of *M. sallei*, *M. africana* or *M. ornata*. However, from Marelli & Gray (1983) and our comparisons of the apophysis in American *M. leucophaeta*, both reveal that the apophysis is much smaller and more deeply attached although the shape is similar. At this point, without supporting data from enzyme electrophoresis, the options are to agree with Marelli & Gray that the European populations are of *M. leucophaeta* or that they are separable and would therefore retain the name *M. cochleata*. Given that *M. leucophaeta* is the only species ranging into temperate waters it is most likely that the European populations, assuming they are alien, are derived from that source and therefore *M. cochleata* and *M. leucophaeta* are synonymous. If *M. cochleata* is a separate species its origins remain obscure.

TABLE 1 Shell outline ratios for 26 specimens of *M. leucophaeta* from Roath Basin, Cardiff Bay.

Dimensions (mm)	Mean	Min	Max	Count
Height/Width	1.24:1	0.99:1	1.66: 1	26
Length/Height	1.90:1	1.64:1	2.23:1	26
Length		7.6	17.9	26

### **DIAGNOSIS**

Small (to 30 mm), mytiliform with a greyish brown lamellar periostracum. Outline elongate to hatchet shaped, ligament margin about one third of the length. Ventral margin straight not concave. Interior of beak with a distinct septum, behind it in the umbonal cavity a triangular plate (apophysis) extends from the hinge plate. Shell greyish white with sparse faint grey zigzag lines, interior porcellanous except for pallial and muscles scars.

Cardiff specimens do not appear to exceed 20 mm in length and are rather variable in shape (Table 1) from subrectangular to hatchet shaped.

### **H**ABITAT

Environmental data on the habitat of *M. leucophaeta* in Europe come primarily from the Netherlands where salinity ranges of 3.5–9.2 ‰ (Van Benthem Jutting, 1943); 0.18–2.7 ‰ (Janssen & Janssen-Kruit, 1967) and 0.09–0.72 ‰ (Kelleher, 1997) are given. Although higher salinity tolerances (to 31.6 ‰) (Wolff, 1969; Kelleher, 1997) are recorded these are considered to be well above the levels preferred for propagation (Wolff, 1969). Wolff (1969) further states that *Mytilopsis* prefers standing or slow-running water where the salinity and temperature fluctuations are small.

Roath Basin, Cardiff Docks is brackish and opens into Cardiff Bay which encompasses the estuaries of the rivers Taff and Ely. The dock remains permanently flooded whereas Cardiff Bay, for the present, is tidal. Roath Basin is also fed by freshwater from a now disused canal feeder. The salinity recorded in the dock is typically 15‰ which agrees with the Dutch lagoonal, low salinity, environments.

Roath Basin is approximately 4 metres deep with walls constructed of large stone blocks. The floor is covered with a black, highly organic, fluid mud. The walls show no sign of colonisation close to the surface but below 1 metre are encrusted with tubes of *Ficopomatus*. Most of the living specimens of *Mytilopsis* were found attached amongst these tubes. *Mytilus* is also found on the walls but also at the base where they consolidate the mud and dead worm tube clumps. Only a few *Mytilopsis* were found in this zone.

The associated fauna in Roath Basin is unusual and includes the brackish water polychaete *Nereis succinea* (Frey & Leuchart, 1847), the alien polychaete *F. enigmaticus* (Fauvel, 1923) and the alien crab *Rhithropanopeus harrisii* (Gould, 1841) (Eno, Clark & Sanderson, 1997). The *Mytilus* specimens have been identified provisionally as *M. galloprovincialis* but they are rather unusual in shape.

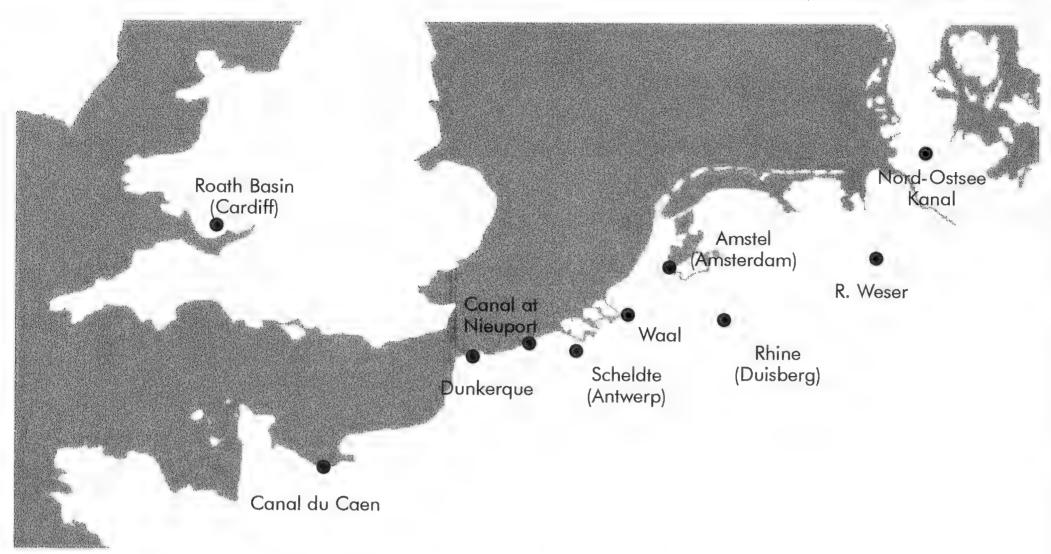


Fig 14 Map showing the distribution of Mytilopsis leucophaeta in Western Europe.

### **DISTRIBUTION**

Given the proximity of the Netherlands/Belgium and the long period of time that M. leucophaeta has inhabited those countries it is surprising that there have been no previous records for the British Isles. Since the inception of the UK Biodiversity Action Plan the majority of natural brackish water lagoons have been surveyed and Mytilopsis has not been noted. The stable, low salinity conditions apparently required by Mytilopsis are probably unusual in that most docks will be regularly replenished with higher salinity water. Roath Dock is constantly fed with freshwater from a canal, but not from the main river and this maintains the low salinity and stability required. Swansea Dock also has reduced salinity as it is fed by the R. Tawe, so on hearing that a ship which had been moored for over five years was to be cleaned, samples were taken from the hull. As in Roath dock the tube worm Ficopomatus was common, as was Mytilus but Mytilopsis was not present. This indicates that Mytilopsis requires rather narrow parameters and may continue to be rare in the British Isles. Given that Mytilopsis has been known in Europe for over 160 years the subsequent minimal dispersion also suggests that it is not an efficient coloniser. We do not know when Mytilopsis invaded Roath Basin but one must assume that it was brought in by shipping either from Europe or directly from North America. The presence of the rare American alien crab Rhithropanopeus perhaps supports the latter. Alternatively the rather uninviting dock environment and restricted access to such sites may have resulted in the paucity of discoveries and Mytilopsis may be more widely found in our larger ports.

### REFERENCES

ADAM W. 1960 Faune de Belgique: Mollusques Institut Royal des Sciences Naturelles de Belgique. Brussels 362–363.

Benthem Jutting T. Van 1943 Mollusca (I) C. Lamellibranchia. Fauna van Nederland 12: 1–477. Leiden.

- ENO N.C., CLARK R.A. & SANDERSON W.G. 1997 Non-native marine species in British waters: a review and directory. Joint Nature Conservation Committee, Peterborough 1–152.
- Germain L. 1931 Mollusques terrestres et fluviatiles. Faune de France 479-897.
- GLOËR P. & MEIER-BROOK C. 1994 Süsswassermollusken. Ein Bestimmungsschlüssel für die Bundesrepublik Deutschland. Deutsche Jugenbund für Naturbeobachtung, Hamburg: 1–136.
- Janssen A.W. & Janssen-Kruit E. 1967 De molluskenfauna van het Kanaal door Voorne in verband met het zoutgehalte. *Correspondentieblad van de Nederlandse Malacologische Vereniging* **122**: 1296–1298.
- Kelleher B. 1997 Leeft Mytilopsis leucophaeta (Dreissenidae) in de Waal Correspondentieblad van de Nederlandse Malacologische Vereniging 297 (juli 1997): 89–91.
- MARELLI D.C. & GREY S. 1983 Conchological Redescriptions of *Mytilopsis sallei* and *Mytilopsis leucophaeta* of the Brackish Western Atlantic (Bivalvia: Dreissenidae) *Veliger* **25 (3)**: 185–193.
- MARELLI D.C. & GREY S. 1985 Comments on the status of recent members of the genus *Mytilopsis* (Bivalvia: Dreissenidae) *Malacological Review* **18**: 117–122.
- MORTON B. 1981 The biology and functional morphology of *Mytilopsis sallei* (Récluz) (Bivalvia: Dreissenacea) fouling Visakhapatnam Harbour, Andhra Pradesh, India *The Journal of Molluscan Studies* 47: 25–42.
- Pilsbry H.A. & Bequaert J. 1927 The Aquatic Mollusks of the Belgian Congo Bulletin of the American Museum of Natural History 456.
- SEED R. 1992 Systematics, evolution and distribution of mussels belonging to the genus *Mytilus*: an overview *American Malacological Bulletin* **9 (2)**: 123–138.
- Wolff T. 1969 The Mollusca of the estuarine region of the rivers Rhine, Meuse and Scheldte in relation to the hydrography of the area. II. The Dreissenidae *Basteria* 33 (5-6): 93-103.

# PROBLEMATIC TAXA FROM MOROCCO - THE STATUS OF "HELIX ARGONAUTULA" WEBB & BERTHELOT, 1833, "HELIX RENATI" DAUTZENBERG, 1894 AND XEROLEUCA ANTOINEI PALLARY, 1936<sup>1</sup>

M.B. SEDDON<sup>2</sup> & M.-T. APARICIO<sup>3</sup>

Abstract "Helix" argonautula (Webb & Berthelot, 1833) has been reported from both the Canary Islands and Morocco but the systematic position of this taxa and it's affinity to the Madeiran Geomitrinae (sensu Mandahl-Barth 1950) is unclear. Examination of shell material from Morocco and Canary Islands have revealed two distinct and differing species, hence the taxonomic status is reviewed. Although most authors attribute the initial use of the name "Helix" argonautula to the species on the Canaries, the type specimens (from Terver) are identical to the Moroccan species, hence the Moroccan taxon should take the name argonautula. The species present on the Canary Islands is not Helix argonautula, and a new species name is given and a lectotype designated from Wollaston material in the Melvill-Tomlin Collection. Helix renati Dautzenberg, 1894 has a similar shell form to moroccan shells of "Helix" argonautula. Given that it is possible to have very similar shells for anatomically different animals both names are maintained until anatomical revision is possible. In addition there is a third species with similar shell characters, Xeroleuca antoinei, described by Pallary from this region. Examination of genital anatomy suggests that this species should be placed in the genus Helicella, and the ecology and distribution of this species is described.

Key words Taxonomy, "Helicopsis" renati, Helicella antoinei, Grand Canary, Morocco, Lectotype.

### Introduction

"Helix" argonautula was first collected by Terver amongst bags of dried orchil (moss) which were given to Webb & Berthelot (1833) who described argonautula as one of forty-four new species in their monograph on the Canary malacofauna. Later work on Madeira, Cape Verde Islands and the Canaries revealed that many of these species were not actually present in the Canaries, but were endemic on Madeira and Cape Verde Islands, leading Wollaston (1878: 298–308, 400–402) to comment on the uncertain provenance of Terver's bags of Ochil.

Lowe and Wollaston collected the first well-localised material of "Helix argonautula" at Arguineguin in the southern part of Grand Canary (Lowe 1861; Wollaston 1878). At this time Lowe (1861) pointed out that there are two species present within the "H. argonautula" described from the Canaries, and separated Helix pulverulenta which is found in the adjacent districts of El Charco, Maspalomas, in the extreme southern tip of Grand Canary (presently considered to be Canariella pulverulenta). But Mousson (1874) reported that Helix argonautula was present on the Moroccan mainland as well as the island of Grand Canary. He defined the typical form of Helix argonautula from Morocco and the varietal form from the Canaries. Wollaston (1878) did not agree with Mousson (1874) believing that the original locality should be the Canaries and the African specimens should be regarded as the varieties.

The range of *Helix argonautula* in W. Morocco was reported as the region of Casablanca (Mousson 1874; Wollaston 1878; Pallary 1936). A similar species *Helix renati* Dautzenberg, 1894 was described from the region of Oualidia, SW. of Casablanca. Pallary (1898) initially recognised this species as separate from the Moroccan specimens of *H. argonautula*, but later (1904) placed *Helix renati* as a junior synonym. A third species *Xeroleuca* 

<sup>&</sup>lt;sup>1</sup> Systematics and Biogeography of the Land-Mollusca of NW. Africa; Contribution no. 12.

<sup>&</sup>lt;sup>2</sup> Biodiversity & Systematic Biology, National Museum of Wales, Cathays Park, Cardiff, CF1 3NP.

<sup>&</sup>lt;sup>3</sup> Museo Nacional de Ciences Natureles, Jose Gutierrez Abascal, 2, 28006 Madrid.

antoinei was described by Pallary (1936) from the phosphate production areas near Khouriba, inland of Casablanca (Fig. 1). This shell has superficially similar characters to the above two species, but differed in the development of the keel and in the larger size of the shell. As part of our review of the land Mollusca of NW. Africa spirit material was collected in the region between Safi and Oualidia which has enabled a re-examination of the taxonomic status of these Moroccan taxa and the results are presented in this paper.

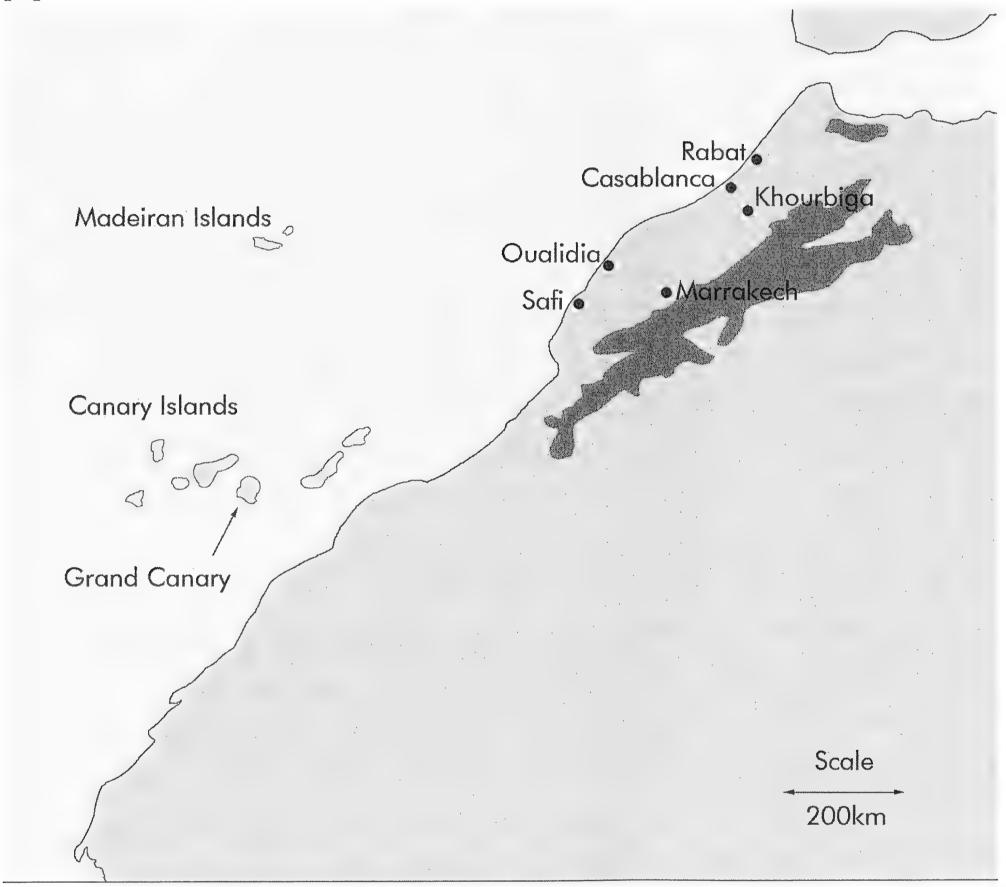
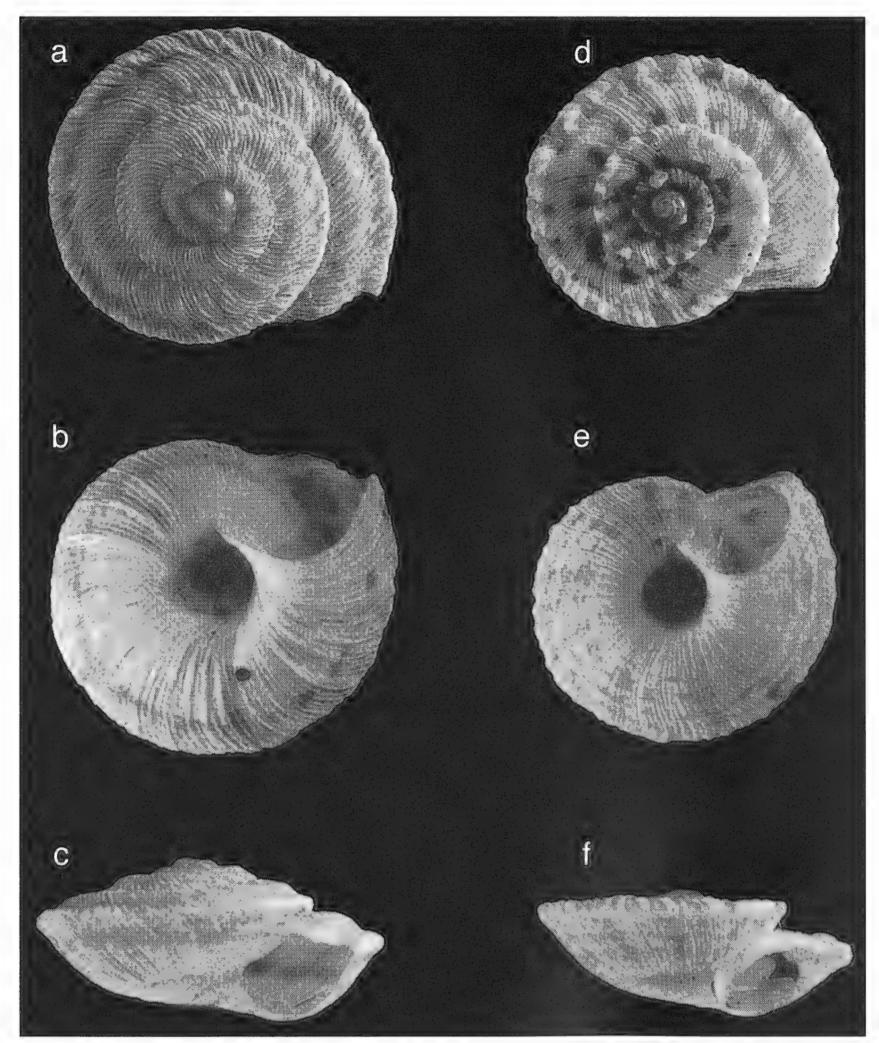


Fig. 1 Map showing localities mentioned in the text. Stippled areas represent mountain regions.

"Helix" arguineguinensis nov. nom. Fig. 2a, b, c

Helix argonautula Webb & Berthelot, 1833, Ann. Sci. Nat., 28 (111), syn. 21, p. 325. Helix argonautula D'Orbigny in Webb & Berthelot, 1839, Canariese: 64, Figs 13–18. Helix argonautula Webb & Berthelot, 1833 in Pfeiffer, 1848, Mon. Hel. 1: 125. Disculus argonautula (Webb & Berthelot, 1833) in Mousson 1872, Fauna Malac. Canaries, 55. Disculus argonautula (Webb & Berthelot, 1833) in Mousson 1874 Jahrb. d. malakozool. Ges., 1: 81

Helix argonautula Webb & Berthelot, 1833 in Pfeiffer, 1876, Mon. Hel. 7: 212. Disculus argonautula (Partim) (Webb & Berthelot, 1833) in Wollaston 1878, Testacea atlantica, 483.



**Fig. 2a, b, c** Lectotype of "Helix" arguineguinensis nov. sp. Melvill-Tomlin Collection, National Museum of Wales (NMW 1955.158.2113): "Helix argonautula" Webb & Berthelot Grand Canary [Colln. Wollaston]. **d, e, f** "Helix" argonatula (Webb & Berthelot, 1833) Melvill-Tomlin Collection Helix argonautula Webb & Berthelot, Casablanca, Morocco [Coll. Pallary].

*Disculus argonautula* var. *canariensis* (Mousson, 1874) in Wollaston 1878, *Testacea atlantica*, 483 (not *Helix canariensis* Shuttleworth in Mousson, 1872 p. 33)

Disculus argonautula (Partim) (Webb & Berthelot, 1833) in Morelet 1880 J. Conchyl. Paris, **28**: 49. Tectula argonautula (Partim) (Webb & Berthelot, 1833) in Tryon (1888) Man. Conch., **4**: 42–43. Jacosta argonautula (Partim) (Webb & Berthelot, 1833) in Pilsbry (1894–6) Man. Conch., **9**: 259. Leucochroa argonautula (Partim) (Webb & Berthelot, 1833) in Richardson (1980) Tryonia **3**: 185.

Material examined Melvill-Tomlin Collection, National Museum of Wales (NMW 1955.158): Helix argonautula Webb & Berthelot Grand Canary [Colln. Wollaston], 2 shells NMW 1955.158.2113. Helix argonautula Webb & Berthelot Grand Canary, 5 shells NMW 1955.158.2114. Helicella pulverulenta Lowe Maspalomas, Canary Islands, [Colln.

Wollaston], 5 shells. NMW 1955.158.2115. University Museum of Zoology, Cambridge, *Helix argonautula* Webb & Berthelot Grand Canary [Colln. Lowe].

Description The shell has 5–5.5 whorls. The shape is flattened and lenticular with a strong, angled keel on the central position and a blunt angle on the upper shoulder of the whorl (Fig. 2c). The umbilicus is relatively open (Fig. 2b). The main part of the shell is mottled light brown, with fine, regular, radial creamy white ribs. The protoconch and first half whorls are more translucent and light brown in colour. The underside of the shell is whitish and although the sculpture is less developed, the radial ribs continue over the keel to the edge of the umbilicus, with a hint of spiral ribbing breaking up the radial ribs. The peristome is not continous, and the mouth is not downturned.

Geographic Range Canary Islands, from the island of Grand Canary.

Taxonomic comments Examination of material of Helix argonautula in the Melvill-Tomlin Collection from Grand Canary (Wollaston Coll.) and from Casablanca (Pallary Coll.) shows that there are differences in shell characters between these two forms:

- 1. The shells from Grand Canary differ in the position of the angled keel which is more central and does not give the shells a turreted appearence.
- 2. The development of shell sculpture which raises the keel on the Moroccan specimens is not present on the shells from Grand Canary Island.

We are grateful to Dr. Ibanez and Dr. Henriguez (Canary Islands) (Pers. comm. June 1993) for confirming that the shell form described by Webb & Berthelot is not found on the Canary Islands. Their photographs of a shell of *H. argonautula* in the Terver collection at Marseilles show characters which are identical to our Moroccan specimens. We have been unable to get spirit material of the Canary Island taxa and therefore cannot confirm the taxonomic position. However, given the differences in shell form we believe that the Moroccan taxa should be retained as a separate species from the Canary Island taxa until full anatomical data is available and the taxonomic position of these taxon is resolved.

Groh & Hemmen (1986) commented that, although they were unable to locate any type material of this species in London (BMNH), Paris (MNHN) or Frankfurt (SMF), on the basis of the illustrations it was allied to *Canariella*. Ponte-Lira (1992) describes all of the *Canariella* species currently known from the Canary Islands. The *Canariella* shells have a size range of between 6–20.5 mm, are typically flattened and keeled, with a clearly defined suture. The size of the umbilicus is variable, but consistently present. The mouth usually has a lip, which is sometimes reflected toward the columellar and basal zone. When ribbing is present on shells the ribs are usually regular, rather than interrupted. The most constant character of the genus *Canariella* is the presence of hairs on the shell, usually visible, even on worn shells around the umbilicus, the suture and on the upper whorls (Ponte-Lira, 1992). Examination of Wollaston material in the NMW collections shows that although some characters of the shell (keel, size, ribbing) are close to other species currently placed in the genus *Canariella* there are no hairs on the shell, the ribbing is interrupted and there is no lip to the mouth and as these are typically found in *Canariella*, this taxon cannot be securely placed with in this genus.

Nomenclatural notes This species always been known as Helix argonautula Webb & Berthelot, 1833, but the material in the Terver collection at Marseilles shows characters which are identical to our Moroccan specimens. In view of the uncertainty relating to



**Fig. 3a, b, c** "Helicopsis" renati Dautzenberg Holyoak-Seddon Collection, National Museum of Wales NW. coast of Morocco by S121 Cap Bouddouza 32°23′N,9°15′W). **d, e, f** Helicella antoinei (Pallary, 1936) Holyoak-Seddon Collection, National Museum of Wales: NW. coast of Morocco by S121 6 km N of Safi (centre) (32°20′N,9°16′W).

the original type locality, we take Mousson's view that the type locality for *Helix argonautula* is in Morocco and as such the species present on the Canary Islands requires a new name. The erroneous locality would explain why Wollaston (1878) commented that he thought it odd that Webb & Berthelot have overlooked *Helix pulverulenta* in the original samples. Wollaston's (1878) name of *canariensis* is not available, and as such we have selected the name "*Helix*" arguineguinensis, which is derived from the site of first

24

well-localised specimens of this taxon collected by Lowe and Wollaston on Grand Canary. The figured specimen is a lectotype and was selected from specimens collected on Grand Canary which came from Wollaston [in Melvill-Tomlin Collection, NMW, Cardiff].

### "Helix" argonautula (Webb & Berthelot, 1833) Fig. 2d, e, f

Helix argonautula Webb & Berthelot, 1833, Ann. Sci. Nat., 28 (111), syn. 21, p. 325. Helix argonautula D'Orbigny in Webb & Berthelot, 1839, Canariese: 64, Figs 13-18. Disculus argonautula (Webb & Berthelot, 1833) in Mousson 1874 Jahrb. d. malakozool. Ges.,1: 81.

Tectula argonautula (Webb & Berthelot, 1833) in Tryon (1888) Man. Conch., 4: 259. Jacosta argonautula (Webb & Berthelot, 1833) in Pilsbry (1894–6) Man. Conch., 9: 259. Xerophila argonautula (Webb & Berthelot, 1833) in Pallary (1898) J. Conchyl. Paris, 44: 93–94. Xeroleuca argonautula (Webb & Berthelot, 1833) in Pallary (1904) J. Conchyl. Paris, 52: 47. Leucochroa argonautula (Webb & Berthelot, 1833) in Richardson (1980) Tryonia 3: 185.

Material examined Melvill-Tomlin Collection Helix argonautula Webb & Berthelot Casablanca, Morocco [Coll. Pallary], 1 shell NMWZ. 1955.158. 2116.

Nomenclatural notes The moroccan specimens of H. argonautula were first described from Dar-el-Abiad in the coastal region of Casablanca (Mousson, 1874). Pallary material is illustrated from Casablanca (Fig. 2 d-f), and is identical to Wollaston material from Morocco. Dautzenberg (1894) later described a similar species H. renati from further south along the coast near Oualidia. Pallary (1898) listed H. renati in his first paper on Morocco, but later modified his view (1904) synomising H. renati with H. argonautula. Pallary continued to use *H. argonautula* throughout his papers. These studies show that the name H. argonautula applies to the Moroccan species which is not conspecific with the Canary Island species. However, in view of the convergence of shell characters which is common in N. African helicellids, it is difficult to establish whether H. renati is a true synonym of H. argonautula, until anatomical material from Casablanca has been examined.

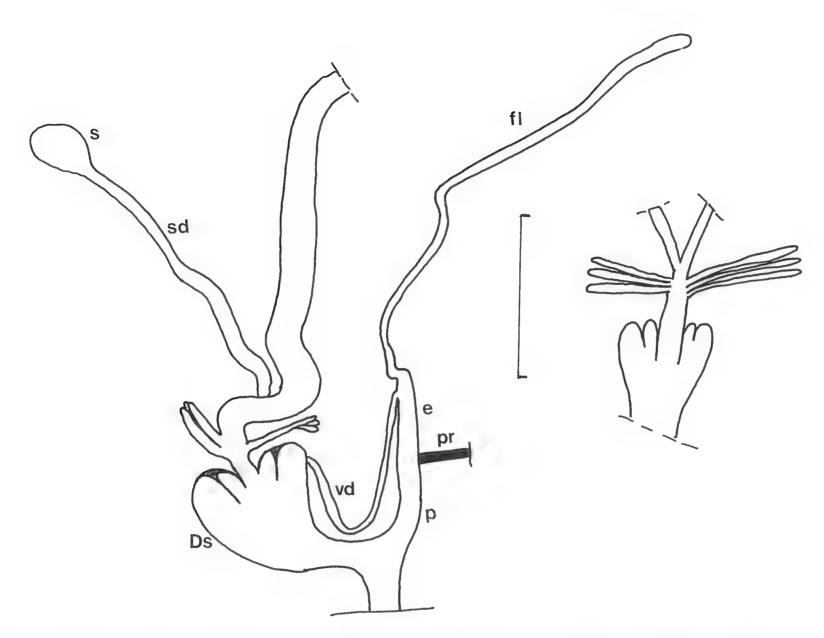
### "Helicopsis" renati (Dautzenberg, 1894) Fig. 3a, b, c, Fig. 4

Helix renati (Dautzenberg 1894) Bull. Soc. Zool. Fr.:17. Xeroleuca argonautula (Webb & Berthelot, 1833) in Pallary (1904) J. Conchyl. Paris, 52: 47. Leucochroa argonautula (Webb & Berthelot, 1833) in Richardson (1980) Tryonia 3: 185.

Material examined Helix renati (Dautzenberg 1894) Holyoak-Seddon Collection, National Museum of Wales.

Locality Just N. of S121 on the northern edge of El Oualidia (32°44′N,9°02′W) (NMW.Z 1993.051.0038) by S121 5 km NE. of Sidi-Moussa (33 °01'N, 8 °42'W). NW. coast of Morocco by S121 Cap Bouddouza 32°23′N,9°15′W) (NMW.Z 1993.051.0039).

The shell has 5–5.5 whorls. The shape is flattened and lenticular with a strong, angled keel on the upper shoulder of the whorl giving a turreted appearence in a side view (Fig. 3b). The umbilicus is moderate showing the last whorl and a half (Fig. 3c). The main part of the shell is opaque, creamy white with sporadic cover of light



**Fig. 4** Figure showing the genital anatomy of "Helicopsis" renati Dautzenberg. Holyoak-Seddon Collection, National Museum of Wales: NW coast of Morocco by S121 Cap Bouddouza 32°23′N,9°15′W). Scale Bar 1 mm.

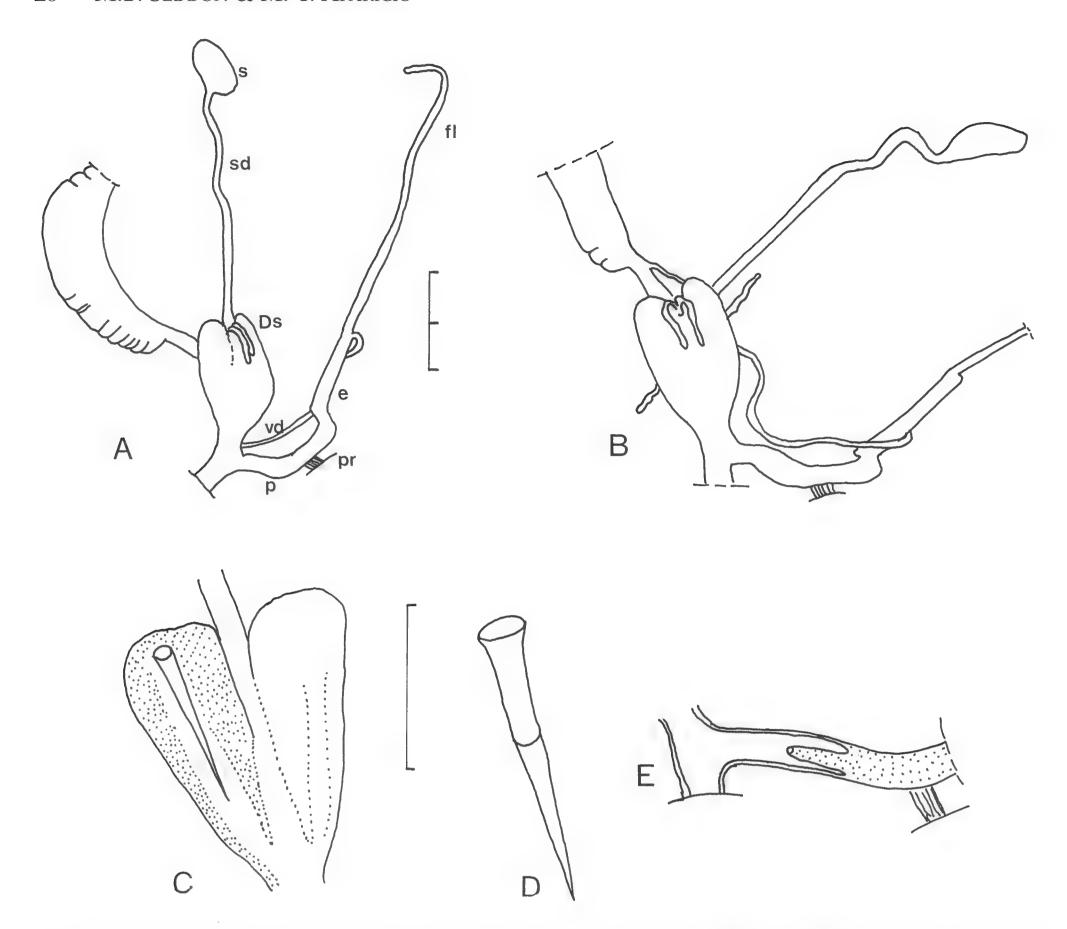
brown flecks. The protoconch and first half whorls are more translucent and light brown in colour. The structure on the upperside is of fine, regular, continuous radial ribs; the interval between the ribs increases from whorl to whorl. The protoconch has no sculpture at x 50 magnification. The sculpture is less developed on the underside of the shell and the radial ribs continue over the keel to the edge of the umbilicus. The shape of the mouth is variable depending on the position of the keel, ranging from hemispheric to nearly crescentic (Fig. 3b). The peristome is not continous.

Genital anatomy Immature specimens were available for examination from two sites (one topotypical), both showing the same level of development. The right ommatophore retractor muscle passes outside the penoviducal angle. There are four dart-sacs in the immature stage.

*Ecology* Three of the four sites were on top of low sea-cliffs (30 m asl.) The species was found living on the undersides of flattened limestone rocks, especially on the hollows of the rock surface rather than the surfaces which were in contact with the soil. These rocks were scattered over the surface with patchy low herbs and grasses. The site was locally sandy with some Eucalyptus trees present.

Taxonomic notes and nomenclatural notes Type material of *H. renati* Dautzenberg, 1894 from Oualidia shows that it is similar to the topotypical material described here (Fig. 3a–c, Fig. 4). Pallary (1898) listed *H. renati* in his first paper on Morocco, but later modified his view (1904) synomising *H. renati* with *H. argonautula*. We retain *H. renati* as a full species until anatomical material from Casablanca has been examined to confirm that Pallary's synomony stands.

We have already documented several examples of the adaption of shell form to the



**Fig. 5** Figure showing the genital anatomy of *Helicella antoinei* (Pallary, 1936). Holyoak-Seddon Collection, National Museum of Wales: NW coast of Morocco by S121 6 km N of Safi (centre) (32°20′N,9°16′W). Scale Bar 1 mm.

environment emphasising the unreliability of shell form for determining generic status in NW. Africa (Seddon *et al.* 1994; Aparicio *et al.*, 1996). Anatomical examination of immature specimens does not provide sufficient data to determine the taxonomic position of this taxa. The genital anatomy (four dart-sacs) appears to suggest that this species is likely to be a *Helicopsis* (*Helicopsis*), but we cannot rule out the possibility of *Helicella* or *Xerolenta*. There is sufficient evidence to say that it is not *Canariella* or *Candidula*. Thus the similarity in shell form beween the *H. renati* and *H. arguineguinensis* appears to be due to convergence rather than the demonstrating a disjunct distribution for single species between Morocco and the Canaries.

*Helicella antoinei* (Pallary, 1936) Fig. 3d, e, f, Fig. 5

Xeroleuca antoinei (Pallary, 1936). J. de Conchyl., Paris, 80: 16–17, Fig. 3. Helicopsis (Xeroleuca) antoinei (Pallary, 1936) in Richardson (1980) Tryonia 3: 183.

Material examined Holyoak-Seddon Collection, National Museum of Wales: NW. coast

of Morocco by S121 6 km N. of Safi (centre) (32°20′N,9°16′W) (NMW.Z 1993.051.0040). NW. coast of Morocco by S121 17 km N. of Safi (centre) (32°23′N,9°15′W) (NMW.Z 1993.051.0041).

Description The shell has 5–5.5 whorls. The shape is flattened and lenticular with a strong, acutely angled keel on the upper shoulder of the whorl giving a turreted appearance in a side view (Fig. 3e). The lower shoulder of the whorl is bluntly angled giving a boat shape to the whorl profile. The umbilicus is moderate showing the last whorl and a half (Fig. 3f). The main part of the shell is opaque, creamy white with sporadic cover of light brown flecks. The protoconch and first half whorls are more translucent and light brown in colour. The structure on the upperside is of fine, regular, discontinuous, radial ribs becoming more pronounced on the keel; the interval between the ribs increases from whorl to whorl. The sculpture is less developed on the underside of the shell and the radial ribs continue over the keel to the edge of the umbilicus. The shape of the mouth is variable depending on the position of the keel, ranging from hemispheric to nearly crescentic (Fig. 3f). The peristome is not continous.

Genital anatomy The right ommatophore retractor passes outside the penoviducal angle. The penis (1.0–1.5 mm) is relatively slender and it contains a penial papilla (Fig. 5a, b, e). The retractor muscle is very short and attached to the diaphragm. The epiphallus (3 mm) is more than twice the length of the penis. The thin flagellum is very long (6 mm), almost twice the length of the epiphallus. There are two medium-sized, dart-sacs (stylophores - 2.5 mm) situated on either side of the vagina with a very small inner sacs. Each dart-sac may contain a medium-sized dart with a structure similar to *Helicella itala*. The vaginal mucous (digitiform) glands have five terminal tubes and are situated beneath and behind the dart-sac complex. The duct of the bursa copulatrix (spermathecae) is quite long (5 mm), with slightly mottled grey pigmentation and has no diverticulum. The bursa copulatrix is bean-like in shape.

*Ecology* These specimens were all found on top of low sea-cliffs (30 m asl.) living on the undersides of flattened limestone rocks, especially on the hollows of the rock surface rather than the surfaces which were in contact with the soil. These rocks were scattered over the surface with patchy low herbs and grasses. The site was locally sandy with some Eucalyptus trees present.

Taxonomic notes The moroccan species have genitalia which are similar to that found with Helicella itala — the type species of the genus Helicella, especially in the structure, size and symmetrical position of the dart-sacs adjacent to the vagina. Prieto (1985), Aparicio & Ramos (1987), Giusti & Manganelli (1989) and Puente (1994) consider Helicella and Xerotrichia to be very close, whereas Hausdorf (1988) comments that they may be separated on the basis of the position of the penial nerve attachment (to the cerebral or pedal ganglion), a character which others comment may be difficult to determine (Giusti & Manganelli 1989). In our view the separation of these two genera (Helicella and Xerotrichia) is unclear and as such we prefer to place this species in the genus Helicella, on the basis of genital anatomy.

The shells look superficially similar to "Helix" argonautula (sensu Pallary) but the granular shell sculpture visible at low magnifications is immediately apparent. The sculpture is interrupted ribbing which gives the impression of a granular shell sculpture similar to, but finer than that of the subgenus Helicopsis (Xeroleuca), and not unlike some of the shell sculpture of the "geomitrid" genera from the Madeiran Islands. Although there are shell characters which would suggest affinities to Helicopsis (Xeroleuca), the presence of two, not four dart sacs in particular would not allow placement within this genus

(Aparicio et al. 1991).

There is also a degree of variability in the shell material from Morocco, as illustrated in the plate. Our material comes from one population close to Safi [= Mogador]. Within this population, the shells vary in the height of the spire, with the shells with fewer whorls appearing flatter. This means that the side profile and the degree to which the shell keel is emphasized varies resulting in different looking shells. The species differs from "Helix" renati in being proportionately larger (9.25–10.5 mm cf. 7–8 mm), with interrupted ribbing, wider umbilicus and more strongly developed keel.

### **C**ONCLUSION

The paper shows that there are three different species, superficially similar in their shell shape present along the Moroccan coast between Casablanca and Safi. The two most northern taxa may be conspecific ("H." renati and "H." argonautula) whereas the third species has a similar shell to some species in the subgenus Helicopsis (Xeroleuca), but the anatomical characters lead us to conclude that it should be placed in the genus Helicella. The species from the Canary Islands is not conspecific with the species from Morocco, and hence a new species name is given and a lectotype designated.

The similarity of shell forms of the above species to species of *Helicopsis* (*Xeroleuca*) and the species described from the Atlantic islands provides further evidence of the way in which species evolve shell forms that are adapted to the local environment. This does not mean that the Moroccan fauna, the Iberian Faunas and the Canaries faunas are not closely related, but that a different sort of evidence needs to be sought rather than using their conchological similarities.

#### **ACKNOWLEDGEMENTS**

Fieldwork was undertaken with D.T. Holyoak and M. Holyoak, without whom this paper would not have been completed. Thanks are due to: Dr. M. Ibanez, Dr. F. Henriguez, Dr. T. Backeljau, Dr. J. van Goetham, Mr. K. Groh, Dr. S. Gofas, Dr. P. Mordan, J. Freeman and K. Way for assistance seeking type material and discussion on comparable species. John Deeming provided assistance translating literature and discussing nomenclature. Kevin Thomas for the photography. Financial support was provided from by the Leverhulme Trust. Assistance was also provided by Nuffield Foundation and the Cheltenham & Gloucester College of Higher Education.

### REFERENCES

APARICIO M.-T. & RAMOS M.A. 1987 New observations on *Helicella stiparum* (Rossmässler, 1854) (Gastropoda, Pulmonata, Helicidae) *Journal of Conchology* **32**: 355–363.

APARICIO M.-T., SEDDON M.B. & HOLYOAK D.T. 1991 Systematics and distribution of *Helicopsis* (Xeroleuca) in Morocco (Mollusca, Gastropoda: Helicidae) Journal of Conchology 34: 47–58.

APARICIO M.-T. & Seddon M.B. submitted. Taxonomy, ecology and distribution of two species of *Candidula* from Morocco (Gastropoda: Pulmonata, Helicoidea) *Journal of Conchology*.

Dautzenberg P. 1894 Description d'un Heliceen nouveau provenant de la côte occidentale du Maroc. Bulletin de la Société Zoologique de France, Paris 19: 17–18.

GROH K. & HEMMEN J. 1986 Geomitra (Serratorula) gerberi n. subgen. n. sp. ans dem Quaterar von

- Porto Santo Archiv für Molleskenkunde 117: 33–38.
- GIUSTI F. & MANGANELLI G. 1989 A new Hygromiidae from the Tyrrhenian islands of Capraia and Sardinina with notes on the genera *Xeromicra* and *Xerotrichia* (Pulmonata: Helicoidea) *Bollettino Malacologico* **25**: 23–62.
- Hausdorf B. 1988 Zur Kenntnis der systematischen Beziehungen einiger Taxa der Helicellinae Ihering 1909 (Gastropoda: Hygromiidae) *Archiv für Molleskenkunde* **119**: 9–37.
- LOWE R.T. 1831 Primitae Faunae et Florae Maderae et Portus Sanctus Cambridge Philosophical Society 4.
- Lowe R.T. 1860 A list of the shells observed or collected at Mogador and its immediate neighbourhood during a few days' visit to the place in April 1859; with notes and observations *Journal of the Linnean Society of London* **5**: 169–204.
- LOWE R.T. 1861 Diagnoses of new Canarian land-snails *Annals and Magazine of Natural History* **3** (7): 104–112.
- Mandahl-Barth 1950 Systematische untersuchungen uber die Helicidae-Fauna von Madeira Abhandlungen hrsg. von der Senckenbergischen Naturaforschenden Gesellschaft. Frankfurt. 469 for 1943: 1–93.
- MOUSSON A. 1874 Bemerkungen über die von Hrn. Dr. von Fritsch und Dr. Rein aus West-Marokko 1872 zurueckgebrachten Land-und Susswasser-Mollusken *Jahrbuch der Deutschen Malakozoologischen Gesellschaft* 1: 1–16, 81–107, pls. 1, 4, 5.
- Pallary P. 1898a Deuxième contribution a l'étude dela Faune malacologique du Nord-Ouest de l'Afrique. Supplement a "La Faune malacologique du Maroc" de A. Morelet *Journal de Conchyliologie. Paris* 46: 49–170, pl. 5–9.
- Pallary P. 1904 Quatrième contribution a l'étude de la Faune malacologique du nord-ouest de l'Afrique. (Deuxième supplement a la "Faune malacologique du Maroc" d'Arthur Morelet) *Journal de Conchyliologie. Paris* 52: 5–58, pl. 1–3.
- Pallary P. 1936 Deuxième complement á la Faune malacologique de la Berberie *Journal de Conchyliologie. Paris* 80: 5–65, pl. 1–4.
- Ponte-Lira C.E. 1992 La subfamilia Ciliellinae (Mollusca Gastropoda: Hygromiidae) en la Archipiélago Canario. Tesis Doctoral (no publicado), Universidad de la Laguna 969 pp.
- Prieto C. 1985 Helicella striatitala sp. nov. (Gastropoda, Helicidae) del N. de la Peninsula Iberica Iberus 5: 53–58.
- Puente A.I. 1994 Estudio taxonomico y biogeografico de la superfamilia Helicoidea Rafinesque, 1815 (Gastropoda: Pulmonata: Stylommatophora) de la Peninsula Iberica e Islas Baleares. Tesis Doctoral (no publicado), Universidad del Pais Vasco. 969 pp.
- SEDDON M.B., APARICIO M.T. & HOLYOAK D.T. 1994 Taxonomy of five species of *Helicopsis* (*Helicopsis*) from Morocco (Gastropoda: Helicidae) *Journal of Conchology* **35**: 45–66.
- Webb & Berthelot 1833 Histoire Naturelle des Iles Canaries, 2, Mollusque. Paris.
- Wollaston T.V. 1878 Testacea Atlantica or the Land and Freshwater shells of the Azores, Madeira, Salages, Canaries, Cape Verdes and Saint Helena Reeve, London.

,		

## THREE NEW SPECIES AND A NEW SUBGENUS OF GULELLA (GASTROPODA: STREPTAXIDAE) FROM TANZANIA

### P. Tattersfield<sup>1</sup>

Abstract Three small species of Gulella from forests in northem Tanzania are described as new species. One of the new species, Gulella spinosa, is the first Gulella or member of the family Streptaxidae which has been reported with a spiny shell.

The new species share several conchological characters which have not been reported elsewhere in the genus Gulella and they are assigned to a new subgenus, Juventigulella. The main characters defining Juventigulella are the conical or conical-ovate shell shape, detached aperture and open umbilicus. The subgeneric name refers to the superficially juvenile appearance of adult specimens. Gulella habibui is designated as the type species.

Key Words Mollusca, Gastropoda, Streptaxidae, Gulella, Tanzania.

### Introduction

With over 150 species of *Gulella* currently described from East Africa (Verdcourt, 1983), and many more from the African continent as a whole, there are sound practical reasons for subdividing the genus into more manageable taxonomic units, even if their systematic relationships are at present uncertain. H.A. Pilsbry erected 11 sections based primarily on conchological characters from material collected in East Africa and the then Belgian Congo, and Connolly (1939) provided an arrangement of the souther African species into 19 groups using mainly apertural dentition and shell sculpture characters.

The three species presented in this paper are unlike any previously described and cannot be assigned to any of the existing subgenera or sections. However, they share several significant characters that seem to merit recognition at least at subgeneric rank. The three species are small and were all located using intensive litter searching and sieving techniques in Tanzanian forests between 1995–97. Their discovery emphasises that there is much to be learned about the smaller elements in the Tanzanian and East African terrestrial molluscan faunas.

This paper is dedicated to my friend Zambia Habibu from Dar es Salaam. Zambia gave me invaluable assistance and support during my fieldwork in 1995 and 1996. He died suddenly at an early age in March 1997.

Kazi hii inatolewa kama kumbukumbu ya Ndugu Zambia Habibu kutoka Dar es Salaam. Zambia alinipa msaada mkubwa wakati wa utafiti mwaka 1995 na 1996. Alifariki ghafla mwezi Machi mwaka 1997 akiwa kijana mdogo.

The following abbreviations for shell dimensions and museums are used:

H Shell height

D Maximum shell diameter

h Aperture heightd Aperture diameter

d<sub>umb</sub> Diameter of umbilicus

AMNH American Museum of Natural History, New York, USA

BMNH Natural History Museum, London, UK

<sup>&</sup>lt;sup>1</sup> Dept. of Biodiversity and Systematic Biology, National Museum of Wales, Cathays Park, Cardiff CF1 3NP, UK.

NMK National Museum of Kenya, Nairobi, Kenya

NMNZ National Museum of New Zealand, Wellington, New Zealand

NMT National Museum of Tanzania, Dar es Salaam, Tanzania

NMW.Z National Museum of Wales, Cardiff, UK

RMNH National Museum of Natural History, Leiden, Netherlands

### Systematic Descriptions

STREPTAXIDAE

Genus *Gulella* L. Pfeiffer, 1856 *Juventigulella* new subgenus

Type species *Gulella (Juventigulella) habibui* n. sp.

Description Small, conical or ovate-conical Gulella species with down-pointing aperture; parietal margin detached or almost completely detached from previous whorl; aperture furnished with well-developed parietal process and basal denticles in adult; aperture of young edentate or with parietal lamella. Embryonic whorls smooth, remainder with strong radial sculpture of ribs, lamellae or spines. Umbilicus open.

Discussion and Comparisons The conical form and open umbilicus of adult shells bear a resemblance to juveniles of other species (e.g. jacquelinae Adam, 1965). However, as adult characters they are like no other section or subgenus previously described.

Three new species, habibui, amboniensis and spinosa are assigned to this subgenus in this paper.

Derivation of name The name refers to the superficially juvenile appearance of adult specimens.

Gender Feminine

### Gulella (Juventigulella) habibui n. sp. Fig. 1

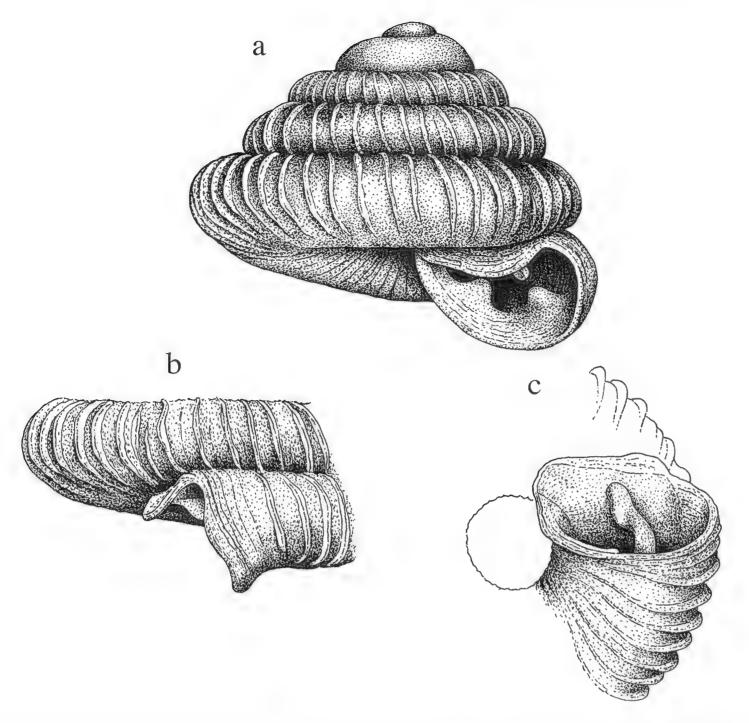
*Holotype* 1sh collected by Z. Habibu and P. Tattersfield, January 1996, by direct searching and sieving forest floor litter and soil, NMW.Z.1997.059.003.

Paratypes 6 adult and 1 sub-adult, as Holotype, NMW.Z.1997.059.006 and in RMNH.

Shell Measurements See Table 1.

Type Locality Kimboza Forest Reserve, Uluguru Mountains, Morogoro District, Morogoro Region, Tanzania. Lowland forest on karstic plateau of Precambrian dolomitic limestone base rocks. Many large boulders, outcrops and karstic features occur within the forest. Specimens collected from forest close to the Morogoro to Kisaki road, 0.5 km to the south of Kibungo Mission, between Mkuyuni and Matombo villages. Altitude: about 350 metres above sea level. Location: 6° 59′ 00″ S 37° 49′ 00″ E.

Lovett and Pocs (1993) describe the indigenous forest as 'seasonal lowland forest, formerly with a 30–40 m high canopy' although they note that the large trees have now



**Fig. 1** *Gulella habibui* n. sp. Holotype a) shell b) side view of aperture c) basal view of aperture showing parietal surface.

been mostly extracted. They estimate annual rainfall as 1700 mm with groundwater influence; the dry season extends from June–August with maximum and minimum temperatures of 28°C and 23°C. In the area where the specimens were collected the canopy was broken and the forest floor either dominated by creepers or with dense accumulations of leaf litter; there was a dense understorey shrub layer extending to about 15 m. Large trees listed by Lovett and Pocs (1993) from the site include *Antiaris toxicaria* Leschen subsp. welwitschii (Engl.) C.C. Berg, Pouteria pseudoracemosa (J.H. Hemsl.), Bombex rhodognaphalon K. Schum., Cordyla africana Lour., Elaeis guineensis Jacq., Khaya anthotheca (Welw.) C. DC. (almost all exploited), Isoberlinia scheffleri (Harms) Greenway, Lettowianthus stellatus Diels, Milicia excelsa (Welw.) Berg Newtonia paucijuga (Harms) Brenan, Parkia filicoidea Welw. ex Oliv., Ricinodendron heudelotii (Baill) Heckel subsp. africanum (Mull. Arg.) J. Leon, and Sterculia appendiculata K. Schum.

Other localities Other material of this species (see Table 1 for dimensions), which match specimens from the type locality, has been recorded from the following sites:

- 1) Lake Duluti, Arumeru District, Arusha Region, Tanzania. Collected: P. Cresswell. Location: about 3° 23′ S 36° 47′ E. Grid reference: 262 540 on Topographical Map 55/4 (Series Y742).
- 2) Mselezi Forest, Mahenge Mountains, Ulanga District, Morogoro Region, Tanzania. Collected: M.B. Seddon, P. Tattersfield, C. Meena. Location: 8° 46′ 50″ S 36° 43′ 00″ E. This forest is on crystalline limestone rocks like the type locality.
- 3) Riverine forest in Mtai Forest Reserve, Tanga Region, Muheza District, East Usambara mountains, Tanzania. Collected: Frontier Tanzania. Location: 38° 46′ E 4° 51′ S, altitude

TABLE 1
Shell dimensions of *Gulella habibui* n. sp.

Specimen	D	Н	d	h	No. ribs on last whorl	No. Whorls	d <sub>umb</sub>
Holotype	1.9	1.5	0.9	0.6	18	$5\frac{1}{3}$	0.4
Paratype 1	1.9	1.4	0.8	0.5	17	$5\frac{1}{4}$	0.5
2	2.0	1.4	0.8	0.5	18	$5\frac{1}{4}$	0.5
3	2.0	1.5	0.8	0.5	19	$5\frac{1}{3}$	0.4
4	2.0	1.5	0.9	0.6	18	5	0.4
5	1.9	1.4	0.7	0.4	Worn off	$5\frac{1}{4}$	0.4
6	1.9	1.5	0.8	0.5	19	$5\frac{1}{8}$	0.4
Specimens from	m forest at	Lake Arui	meru, Aru	sha			
1	2.0	1.6	0.8	0.6	19	$5\frac{1}{3}$	0.5
	2.0	1.6	0.9	0.6	18	$5\frac{1}{3}$	0.5
	2.1	1.6	0.9	0.5	17	$5\frac{1}{3}$	0.4
	2.0	1.6	0.8	0.5	19	$5\frac{1}{3}$	0.4
	2.0	1.6	0.9	0.6	20	$5\frac{1}{2}$	0.5
	2.0	1.7	0.9	0.6	19	$5\frac{1}{2}$	0.5
	2.0	1.6	0.9	0.6	18	$5\frac{1}{2}$	0.5
	2.0	1.6	0.9	0.6	18	$5\frac{1}{4}$	0.5
	2.1	1.6	0.8	0.5	18	$5\frac{1}{3}$	0.5
	2.0	1.6		Broken		$5\frac{1}{2}$	0.5
	2.0	1.6	0.8	0.5	17	$5\frac{1}{3}$	0.4
	2.1	1.6	0.9	0.6	17	$5\frac{1}{2}$	0.5
	2.1	1.7	0.9	0.6	17	$5\frac{1}{3}$	0.4
	2.0	1.6	0.8	0.5	19	$5^{3}/_{4}$	0.5
	2.0	1.6	0.9	0.5	19	$5\frac{1}{3}$	0.5
Specimens from	m Mselezi	Forest. Ma	ihenge Mc	ountains			
operations in	1.9	1.5	0.9	0.7	18	$5\frac{1}{4}$	0.4
	2.0	1.6	1.0	0.6	18	$5\frac{1}{2}$	0.4
	1.9	1.6	0.8	0.6	18	$5\frac{1}{4}$	0.4
	1.9	1.6	0.9	0.6	18	$5\frac{1}{2}$	0.4
	2.0	1.6	1.0	0.7	18	$5\frac{1}{4}$	0.4

All dimensions in mm.

Number of ribs refers to number visible on face of the last whorl.

200 m asl.

4) Lowland forest in Kwamgumi Forest Reserve, Tanga Region, Muheza District, East Usambara mountains, Tanzania. Collected: Frontier Tanzania. Location: 38° 44′ E 4° 57′ S, altitude 200 m asl.

Description Shell minute, conical, white, dextral with flat base and quite deeply impressed suture. Whorls  $5\frac{1}{3}$  (paratypes  $5-5\frac{1}{3}$ ), the first  $2\frac{1}{2}$  smooth and the remainder ribbed. About 9-10 ribs/mm on face of body whorl but more closely spaced on preceding whorls with 14/mm and 11/mm on whorls 3 and 4 respectively. Ribs extend weakly onto the periphery of the base of the shell which is otherwise smooth. Umbilicus open, about 20% of diameter of the shell.

Aperture wider than high with three processes. Peristome reflected on columellar and basal edges, continuous across parietal region. The central part of the parietal peristome is detached from the preceding whorl so as to form a tongue-like process. Short, linear

parietal denticle extends spirally and for a short distance into shell aperture behind the tongue-like process. Two slightly inset denticles on base of aperture; one at junction of outer and basal regions and the second at the junction of basal and columellar regions.

Juvenile shells have simple peristome and aperture with a distinctive spiral, parietal lamella running internally. They lack both the peristome across parietal area and the two basal dentides.

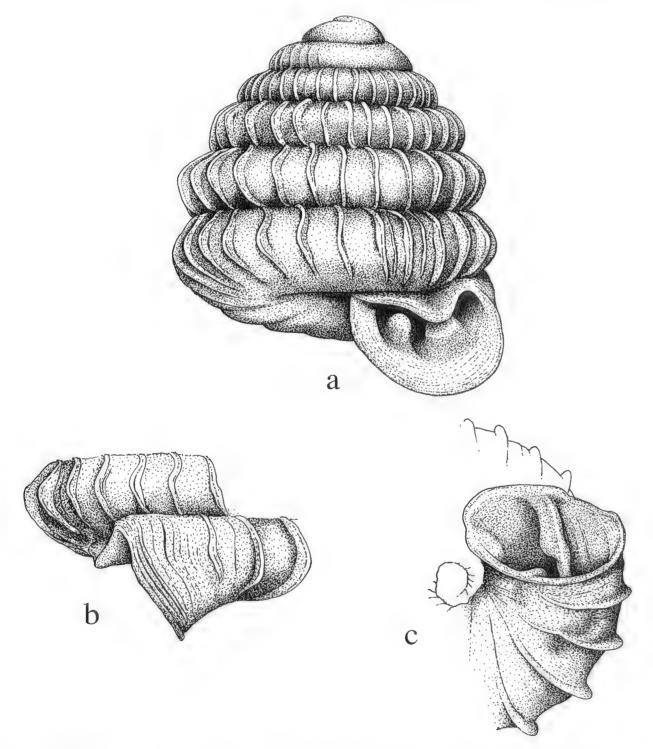
Derivation of name This species is named in appreciation of the assistance provided to me by Zambia **Habibu** from Dar es Salaam who died in March 1997.

Comparisons The conical shape and open umbilicus makes this species of Gulella very distinct and different from all others previously described from East Africa. A search of the wider literature, and of the collections in BMNH and NMW, have failed to identify any taxa with similar characters from anywhere in the world. This species is clearly related to Gulella amboniensis and the possible relationships between these two taxa are discussed below.

## Gulella (Juventigulella) amboniensis n. sp. Fig. 2

*Holotype* 1sh collected by P. Tattersfield, March 1995, by sieving forest floor litter and soil and direct searching, NMW.Z.1997.059.002.

Paratypes 24 adult and sub-adult paratypes, as Holotype, NMW.Z.1997.059.005 and in



**Fig. 2** *Gulella amboniensis* n. sp. Holotype a) shell b) side view of aperture c) basal view of aperture showing parietal surface.

### 36 P. Tattersfield

### NMT, NMK, RMNH, AMNH, BMNH.

Additional specimens collected at the same time by K.C. Emberton from type locality and also from Bomole, Amani-Zigi and Kihuhwi-Zigi Forest Reserves, East Usambaras, Tanga Region, Tanzania (Emberton *et al.* (1997)). Voucher material collected by Emberton *et al.* (1997) has been deposited in the Museum of Zoology, University of Dar es Salaam and with the Molluscan Biodiversity Institute, USA (morpho-species: MBI Streptaxid 25).

Shell Measurements See Table 2.

*Type Locality* Mkulumuzi Gorge, near Amboni Caves, Tanga Municipal District, Tanga Region, Tanzania. Degraded and fragmented coastal forest strip along and beneath cliffs of Jurassic limestone. Location: 05° 05′ S, 39° 02′ E. Altitude: about 30 m above sea level.

Description Shell minute, white, dextral and conical with convex sides and a flat base. Whorls  $6^{3}/_{4}$ , (6–7 on paratypes). First  $2^{1}/_{4}$  whorls smooth, remainder with moderately widely spaced costae, about 6/mm on face of body whorl becoming more closely spaced on preceding whorls with 12/mm and 8/mm on whorls 4 and 5 respectively. Costae extend onto base of shell but become weaker at opening of umbilicus. Umbilicus open, about 10% of diameter of shell.

TABLE 2 Shell dimensions of *Gulella amboniensis* n. sp.

		of the difference of duction and officials it. sp.							
	D	Н	h	d	No. Costee on last whorl	No. Whorls			
Holotype	1.9	2.1	0.6	0.9	11	$6^{3}/_{4}$			
Paratype 1	2.0	2.2	0.6	0.9	12	$6\frac{1}{2}$			
2	1.9	2.2		Broken	10	$6\frac{1}{4}$			
3	1.9	2.3	0.6	0.9	10	$7^{1}/_{3}$			
4	1.9	2.2	0.6	0.9	11	7			
5	1.9	2.2	0.6	0.9	10	$7\frac{1}{3}$			
6	2.0	2.3	0.7	0.9	10	$7\frac{1}{2}$			
7	2.0	2.1	0.6	1.0	11	$6^{3}/_{4}$			
8	1.9	2.2	0.6	0.9	12	6			
9	1.9	2.4	0.6	0.9	11	$7\frac{1}{2}$			
10	1.8	2.2	0.6	0.9	12	7			
11	1.9	2.3	0.7	0.9	12	$6\frac{3}{4}$			
12	2.0	Obscured	by	body	10	$6\frac{1}{2}$			
13	2.1	Obscured	by	body	12	$6\frac{3}{4}$			
14	2.0	2.1	0.6	0.9	11	$6\frac{3}{4}$			
15	1.9	2.1	0.6	0.9	12	$6\frac{1}{2}$			
16	1.9	2.1	0.6	0.9	11	$6\frac{1}{4}$			
17	2.0	2.1	0.6	0.9	10	$6\frac{1}{2}$			
18	1.9	2.0	0.7	0.9	11	$6\frac{3}{4}$			
19	1.9	2.1	0.6	0.9	12	$6\frac{3}{4}$			
20	1.9	2.1	0.6	0.9	11	$6\frac{1}{2}$			
21	2.0	2.2	0.6	0.9	10	7			
22	1.8	2.0	0.6	0.8	10	$6^{3}/_{4}$			
23	2.0	2.0	0.6	0.9	12	~ 7			
24	1.9	2.1	0.6	0.9	11	7			

All dimensions in mm.

Number of costae refers to number visible on face of the last whorl.

Aperture wider than high with three processes. Peristome reflected and continuous, central part of parietal edge detached from preceding whorl and slightly extended to form a triangular, tongue-like process which internally enters into the aperture as an angular lamella. Two further denticles on base of aperture, slightly inset. One at junction of outer and basal areas and the second at the junction of basal and columellar areas.

Juvenile shells have simpler aperture with a distinctive spiral, parietal lamella running intemally. They lack both peristome across parietal area and the two basal

denticles.

Derivation of name The specific epithet refers to the type locality, Amboni.

Comparisons As with Gulella habibui, searches of museum material and the literature have failed to identify any streptaxid taxa that are similar to this distinctive species.

Gulella habibui and Gulella amboniensis have broadly similar shell morphologies, almost identical apertural dentition and juveniles have a closely similar internal spiral, parietal lamella; these two species are clearly closely related. However, they are morphometrically distinct and occupy non-overlapping areas on H/D and whorl number/D plots (see Figs 4 and 5). The size of habibui appears to vary slightly across its geographical range but the number of whorls does not change substantially.

Several characters separate these two species. At adulthood, *habibui* has about 1.5 fewer whorls than *amboniensis*. It has weaker but more closely spaced ribs, a wider umbilicus which occupies a relatively greater proportion of shell diameter, and a greater

apex angle than amboniensis.

A few other species of *Gulella* have been described as having conical or cone-shaped shells. *Gulella conica* (von Martens) differs in that it has a much taller, smooth shell and is edentate, or with only weakly developed apertural processes. *Gulella conoidea* Verdcourt was described from the East Usambara foothills, which are geographically very close to Amboni. However, Verdcourt's (1996) figure shows a much taller shell with 8 whorls and an apex with a much smaller angle. Furthermore, *conoidea* has 4-fold dentition and the parietal edge of the aperture is not detached from the previous whorl. *Gulella cuspidata* Verdcourt and *G. radius* (Preston) have a cuspidate and acute apex respectively, but they are generally much more ovate in outline rather than truly conical.

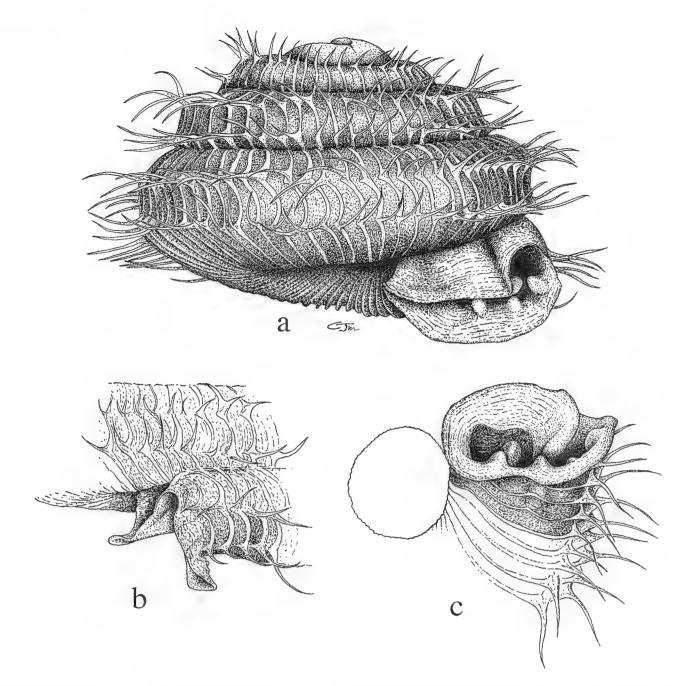
## Gulella (Juventigulella) spinosa n. sp. Fig. 3

Holotype 1sh collected by P. and D. Cresswell from forest floor leaf litter in May 1996. NMW.Z.1997.059.001.

Paratypes 18sh, as Holotype, NMW.Z 1997.059.004 and in NMT, NMK, RMNH, NMNZ, AMNH, RMNH.

Shell Measurements See Table 3.

Type Locality Kifufu, Moshi District, Kilimanjaro Region, Tanzania. Forest on lower, westem slopes of Mount Kilimanjaro. Found by direct searching and sieving leaf litter from a degraded area of forest comprising scattered large trees with dense, low weedy herbaceous growth interspersed with some woody regeneration. The leaf litter on the site had accumulated to a depth of up to 100 mm deep, and was moist at the time of sampling (shortly after the end of the rainy season). Location: 3° 9′ 30″ S 37° 4′ 25. E. Altitude: about 1310 m above sea level.



**Fig. 3** *Gulella spinosa* n. sp. Holotype a) shell b) side view of aperture c) basal view of aperture showing parietal surface.

TABLE 3
Shell dimensions of *Gulella spinosa* n. sp.

	Shell difficults of Guiena spinosa it. sp.						
	D	Н	d	h	No. ribs on last whorl	No. Whorls	d <sub>umb</sub>
Holotype	2.3	1.7	1.0	0.6	26	5	0.6
Paratype 1	2.3	1.7	0.9	0.6	25	$4\frac{7}{8}$	0.6
2	2.3	1.6	0.9	0.6	28	5	0.6
3	2.2	1.6	0.9	0.6	26	5	0.5
4	2.3	1.7	0.9	0.6	27	5	0.6
5	2.3	Broken	1.0	0.7	27	Broken	0.6
6	2.3	1.7	1.0	0.7	26	$4^{1}/_{2}$	0.6
7	2.3	1.7	0.9	0.6	25	$4^{3}/_{4}$	0.5
8	2.2	1.7	0.9	0.6	23	5	0.5
9	2.3	1.7	1.0	0.6	26	$4^{3}/_{4}$	0.6
10	2.3	1.7	0.9	0.6	25	$4^{3}/_{4}$	0.6
11	2.3	1.7	0.9	0.6	26	$4^{1}/_{3}$	0.6
12	2.3	1.8	0.9	0.6	25	$4^{3}/_{4}$	0.6
13	2.0	1.4	0.8	0.6	23	$4^{1}/_{4}$	0.6
14	2.3	1.7	1.0	0.6	25	$4^{1}/_{2}$	0.6
15	2.3	1.7	0.9	0.6	25	5	0.6
16	2.3	1.7	1.0	0.6	25	5	0.6
17	2.3	1.7	1.0	0.6	27	5	0.5
18	2.1	1.7	0.9	0.5	24	5	0.6

All dimensions in mm.

Number of ribs refers to number visible on face of the last whorl.

Description Shell minute, dextral, white and translucent, depressed conical with rather tumid whorls and quite deeply impressed suture. Whorls 5. Whorls 1 and 2 smooth; whorls 3, 4 and 5 with closely spaced lamella-like ribs, c. 11 per mm on body whorl, bearing two rows of flexible spines c. 0.35 mm long, on each side of the periphery of the whorls. The ribs extend onto the base of the shell and into the umbilicus. Umbilicus wide, about one quarter of the diameter of the shell.

Aperture with 5 processes; wider than tall and partly obscured by complex dentition. Extended and completely detached from previous whorl. Pointing downwards at an angle of c.  $30^{\circ}$  from axis of the shell. Peristome reflected. Single parietal denticle, 0.26 mm long, located entirely on the base of the previous whorl (ie. not on the detached mouth) about 0.35 mm behind the peristome. Parietal edge of mouth runs smoothly into a sharp angular lamella that enters deeply into the mouth to a depth of c. 0.61 mm. The angular lamella is marked externally by a groove on the upper surface of the detached mouth. There is a single, palatal denticle which almost reaches the peristome and is located directly opposite the angular lamella, thus forming an almost square sinus. Three basal denticles which are slightly inset into the mouth and do not extend onto the reflected lip. The strongest basal denticle is closest to the columellar margin and the weakest closest to the outer margin. A juvenile with 4.25 whorls is devoid of apertural processes; however, examination of further juvenile material would be desirable to confirm whether all ages of juveniles are edentate.

Derivation of name The specific epithet describes the spiny shell.

Comparisons Searches of the literature have failed to locate any other species of Gulella with the long flexible spines present on the shell of this species. Acanthennea ennacea von Martens and Wiegmann, 1898 from the Seychelles has two rows of short, rather triangular spines projecting from radial lamellae but in other respects is dissimilar being

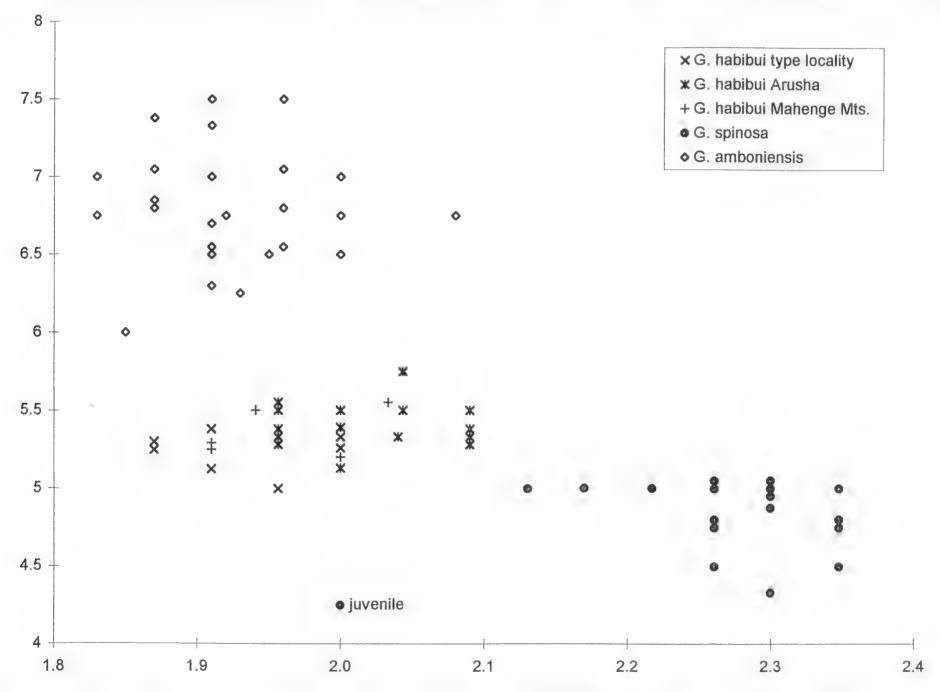


Fig. 4 Shell height (mm) against shell diameter (mm) for three new species of Gulella.

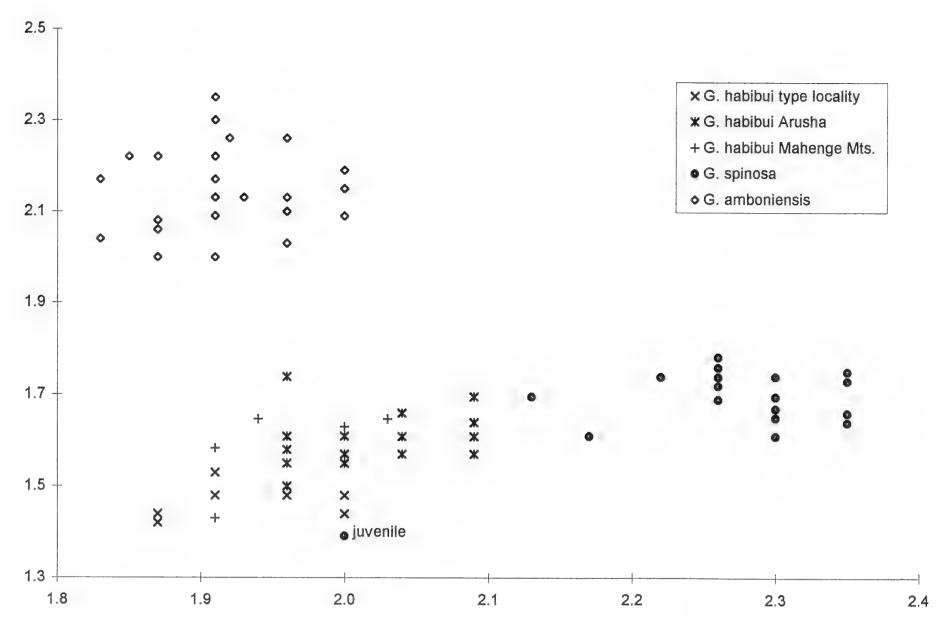


Fig. 5 Whorl Number against shell diameter (mm) for three new species of Gulella.

larger, edentate when adult, with a different aperture and closed umbilicus. A search of the literature has located no other Streptaxidae with spines.

Gulella spinosa differs from the other two species placed in Juventigulella in that it has a spiny shell and lacks juvenile parietal dentition. However, it has been included in the subgenus because of its open umbilicus, general shape, strong radial sculpture and morphology of the adult aperture. It occupies a separate area on the H/D and whorl number/D graphs (Figs 4 and 5).

#### **ACKNOWLEDGEMENTS**

Thanks go to Pete and Dee Cresswell who collected *spinosa*, provided ecological data about the type locality and gave me permission to describe the species. Zambia Habibu and Drs Ken Emberton and Tim Pearce provided assistance and support during my 1995 field trip. Zambia and Caroline Michael and many other local Tanzanians helped during the 1996 fieldwork.

Several people have given me advice and provided helpful suggestions; I am especially grateful to Dr Bernard Verdcourt, Dr Mary Seddon, Dr A.C. van Bruggen, Dr Ton de Winter, Dr Jon Lovett and Mr Fred Naggs. Mr Chris Meecham, National Museum of Wales provided the excellent drawings.

The Tanzania Commission for Science and Technology granted permission to undertake the research in Tanzania. The local co-ordinator was Dr Peter Kasigwa, University of Dar es Salaam. In Tanzania, Dr Bill Newmark and Professor Kim Howell also provided me with advice and assistance. The Tanzania Department of Forestry and Beekeeping, Catchment Forestry, and District Forestry Officers provided support and gave permission to work in the Forest Reserves.

The British Ecological Society, Linnean Society and the Peoples Trust for Endangered Species generously supported the fieldwork.

41

I am also grateful to Frontier Tanzania for the opportunity to examine material collected during their expeditions and for their permission to publish records.

#### REFERENCES

- ADAM W. 1965 Mollusca Streptaxidae. Mission Zoologique de l'I.R.S.A.C. en Afrique Orientale Annales Musée Rouyal de l'Afrrique Centrale. Tervuren. Zoologiques 138: 1–52.
- Connolly M. 1939 A monographic survey of South African non-marine Mollusca *Annals of the South African Museum, Cape Town* **33**: 1–660.
- EMBERTON K.C., PEARCE T., KASIGWA P.F., TATTERSFIELD P. AND HABIBU Z. 1997 High diversity and regional endemism in land snails of eastern Tanzania *Biodiversity and Conservation* 6: 1123–1136.
- LOVETT J.C. AND Pocs T. 1993 Assessment of the Condition of the Catchment Forest Reserves, a botanical appraisal *Catchment Forestry report*. 93.3. Dar es Salaam, Tanzania 300 pp.
- Martens E. von and Wiegmann F. 1898 Land- und Susswassermollusken der Seychellen, nach den Sammiungen von Dr. Aug. Brauer *Mitteilungen aus dem Zoologischen Museum in Berlin* 1: 1–94.
- VERDCOURT B. 1983 A list of the non-marine Mollusca of East Africa (Kenya, Uganda, Tanzania, excluding Lake Malawi) *Achatina* 11: 200–239.
- VERDCOURT B. 1996 A new species of *Gulella* Pfr. (Gastropoda Pulmonata, Streptaxidae) from NE. Tanzania *Basteria* **59**: 135–137.

## REDESCRIPTION OF CORIOCELLA NIGRA DE BLAINVILLE 1825 AND CHELYONOTUS TONGANUS QUOY AND GAIMARD 1832 (GASTROPODA: PROSOBRANCHIA: LAMELLARIIDAE)

#### W. WELLENS M.D.<sup>1</sup>

Abstract On the basis of a single specimen from the island of Mauritius, de Blainville described Coriocella nigra as a new species. Quoy and Gaimard made no distinction between this species and Chelyonotus tonganus, from the island of Tonga in the South Pacific. With the help of the museums of natural sciences of Paris and Berlin and observations of seven living specimens of C. nigra and four living specimens of Chel. tonganus, a redescription of these two lamellarids is given.

Key words Coriocella nigra de Blainville, 1825, Chelyonotus tonganus Quoy & Gaimard, 1832, Lamellariidae, Taxonomy, Redescription.

#### Introduction

De Blainville (1825) presented in his Manual (pl. 42, Fig. 1) drawings of the dorsal and the ventral views of a new lamellarid from the island of Mauritius, remarking: "le dos est peu bombé sans trace de coquille extérieure ni intérieure". Quoy and Gaimard (1832) supposed they found the same mollusc near the island of Réunion, Mauritius and Tonga and gave a more precise description: "Le Sigaret de Tonga a des larges tubercules, arrondis peu élèvés-il est d'un beau noir velouté, excepté vers la racine du pied, qui est brun rouge assez vif. Nous n'avons point trouvé de differences, par rapport aux animaux entre cette espèce et celle de l'Ile-de-France (Réunion); il en existe cependant de constantes dans les coquilles. Ce fut un jeune de cette espèce dont M. de Blainville fit dans le temps son genre Coriocella qui n'est véritablement qu'un Sigaret". Quoy and Gaimard (1832) presented in their Atlas (pl. 66 bis) drawings of the ventral surface of a male specimen (Fig. 4), a side view with polygonal fields (Fig. 5), the shell in situ (Fig. 6), and the shell removed (Fig. 7). Although Quoy and Gaimard described their finds as Sigaret de Tonga, Swainson proposed in 1840 to change this name to Chelinotus, signifying dorsum characteristics resembling those of a tortoise's back. He considered Sigaretus belonging to the Naticidae. In 1846 Hermannsen emandated Chelinotus to Chelyonotus for etymological reasons: χεληs **thorax**, νωτοs **tergum** (Wellens, 1995).

Cuvier (1850) published the drawings of Quoy and Gaimard (pl. 49, Fig. 2) and gave as comment: "The animal, provided with a complete internal shell, belongs to the genus

Sigaretus and the genus Coriocella (de Blainville) is improper" (trans.).

Martens (1880) mentions no differences between the molluscs found on Mauritius and Tonga. The drawing (Tafel 21, Fig. 9) gives a side view of the animal with the head and one large dorsal boss surrounded by polygonal fields. Tryon (1886) reproduces on pl. 27 Fig. 16 the drawing by de Blainville entitled *Lamellaria nigra* Blainville, and on pl. 26, Fig. 11, the drawing of Quoy and Gaimard entitled *Lamellaria Tongana*, without further explanations. Bergh, 1886 mentions the capture by Prof. Mobius of two molluscs on Fouquets-Riff (Mauritius) with the general form of *Chelyonotus semperi* except for the dorsal bosses which are hardly distinguishable. Bergh considers these animals as related to *Chelyonotus semperi*. There has been much confusion in the description of the dorsum of *Coriocella nigra* and of *Chelyonotus tonganus* because de Blainville and his contempo-

<sup>&</sup>lt;sup>1</sup> Scientific associate R.B.I.N.S. Malacology Section, Vautierstr, 29, Brussels, 1040, Belgium.

TABLE 1 Information on the eight specimens of *Coriocella nigra* after preservation in alcohol, ranked according to length.

$N^{\circ}$	Location	Date of capture	Length	Animal Breadth	Height	Foo Length I	ot Breadth	Shell max. diam.
1	M	X/93	66	41	27	28	9	23
2	$\mathbf{M}$	X/93	61	40	32	32	11	20
3	R	XI/92	53	32	20	23	7	21
4	R	XI/92	46	28	19	20	6	17
5	R	XI/93	44	26	21	19	7	22
6	R	1984	43	19	17	26	6	15
7	M	1886	40	30	16	16	7	16
8	R	1984	30	18	13	17	5	19

The measurements of the eight specimens of *Coriocella nigra* were made with calipers and are given in mm. The internal shell diameter was measured on X-Ray photographs. M= Mauritius, R= Réunion. N° 1 was used for the description and N° 7 is the specimen on loan from Berlin. All the specimens were male.

raries Quoy and Gaimard did not observe the living animals; between the time of the capture and the delivery on board the volume of the bosses can change. During field work I remarked that in certain species of Lamellariidae the bosses disappeared after a few hours. Because the dorsal bosses are species specific, a redescription is necessary.

#### MATERIAL EXAMINED

Dr. Bouchet (Museum National d'Histoire Naturelle, Paris) sent a type labelled as "Holotype" of *Coriocella nigra*, de Blainville 1825. Except for the penis, the shrivelled remains gave poor information on the external morphology but the radula was similar to the radula of our specimens. Prof. Kilias (Museum fur Naturkunde der Humboldt Universitat, Berlin) sent dissected parts from "2 Tiere von *Coriocella nigra* Quoy and Gaimard Mauritius-Möbius" and "1 Tier *Coriocella nigra* Quoy and Gaimard Fouquets, Mauritius Kat. N° 32148 Möbius". There was no material of *Sigaretus Tonganus*. We asked the Zoologisk Museum Kobenhavn for material of *Chelyonotus tonganus*, but nothing was conserved in their collections except for the shell of *Chelyonotus semperi*.

During a stay in Réunion (November 1992) I received two specimens of *Coriocella nigra* (preserved in alcohol) from Dr. M. Jay and we collected two live specimens from the same site referred to as "le plattier de Grand-Fond" near St. Gilles les Bains.

In October 1993 during a stay on Mauritius we collected three live specimens of *Coriocella nigra* off the coast of the village of Flic en Flac.

During a stay in Tonga (February 1996) we found five live specimens of *Chelyonotus tonganus*.

All the specimens are deposited in the collections of the Royal Belgian Institute of Natural Sciences (R.B.I.N.S.). *Coriocella nigra* under N° 28030 (1995). *Chelyonotus tonganus* under N° 28338 (1996).

## REDESCRIPTION OF CORIOCELLA NIGRA, DE BLAINVILLE, 1825

On 21 October 1993 the first animal (N° 2) was captured in the bay near Flic en Flac, at low tide in 1.2 m of water on white sand at the base of branching coral. Because of the

loss of pigment we chose the second collected specimen ( $N^{\circ}$  1) for the description. It was found five days later in the same bay under the same circumstances as the first. The third specimen ( $N^{\circ}$  5) was captured one day later. The three specimens were completely black and had three dorsal bosses in a line perpendicular to the length axis of the dorsum. Soon after the death of these live observed specimens the volume of their bosses decreased and their form vanished. Only an indication of the bosses could be recognized (Figs 3–4).

The head moves its white-tipped, 10 mm long tentacles under the inhaling siphon of about 3 mm length. The foot, extremely flat, is as long as the animal and has a width of

20 mm with a rectangular proximal part and a pointed posterior end.

The measurements of this freshly dead specimen are: length 70 mm; maximum breadth and maximum height 38 mm, both measures are located 10 mm after the line perpendicular on the middle of the length axis. The central boss has a diameter of 12 mm and its height is 7 mm; the two lateral bosses, each at a distance of 4 mm from the big boss, have a diameter of 6 mm and a height of 3 mm. The proximal part of the mantle forms nearly symmetrical covers on the ventral side of the mollusc. They do not cover the distal 10 mm of the retracted foot. Between the central boss and the proximal and caudal ends of the mantle are five polygonal fields.

The third specimen (N° 5) was captured one day later. Soon after the death of these live observed specimens the volume of their bosses decreased and their form vanished;

only an indication of the bosses could be recognized.

For the dissection of the penis, the jaws and the radula we used specimen N° 6 which has a fractured shell. The penis (Fig. 5) is sickle-shaped. The measures are: length 16 mm, breadth 3 mm maximum and 2 mm at the end.

The peripheral part of the penis, about 1 mm broad, is thinner than the rest. The penis tip has a length of 0.5 mm. The color on the internal side is black and dark-grey on the external side. The male duct is enclosed in the body wall. This anatomical peculiarity separates the genera *Coriocella* and *Chelyonotus* from the genus *Lamellaria*.

The jaws (Fig. 6) are saddle-shaped with a length of 2 mm and a height of 1 mm.

The radula (Figs 7–10) has a length of 15 mm and a width of 0.9 mm. There are 40 rows of teeth for 10 mm of radula length. The radula is asymmetrical: the angle made by the teeth rows and the longitudinal axis of the radula is 20°. The formula of the reduced taenioglossate radula is 0-1-1-1-0. The right leg of the rachidian is more developed than the left one. Its maximum height is 275 µm and its base has a length of 262 µm. Both sides of the top bear 3 or 4 denticles.

The lateral teeth have a maximum length of 723  $\mu$ m and a maximum width of 235  $\mu$ m. The external side of the "canine protuberance" bears about 20 denticles with a base and a height of about 3.5  $\mu$ m. Their interspaces diminish towards the top. The top side of the lateral teeth bears 7 denticles with a height and a base of 7  $\mu$ m. Dr. Jay (Réunion) gave me three shells of *C. nigra*, found on "le plattier de Grand Fond". These auricular shells are thin and fragile. They have  $3\frac{1}{2}$  whorls with an impressed suture. The spire is obtuse and small and the body whorl is very large. The aperture is transversely oval and very wide. The columella is open so that the inner cavity of the protoconch can be seen when looking within the umbilicus. A thin white callus is present along the inner lip. A periostracum and growth-lines are visible. The white color alternates with zones of transparency.

TABLE 2
Measurements and weights in mm and grams of 3 shells of *C. nigra* from Réunion.

Max. diameter	Max. height	Max. diameter of aperture	Weight
30	12.5	21x17	1.615
25	12.5	16x15	0.838
24	10	19x14	0.377

#### **DISCUSSION**

De Blainville (1825) published few details of the general aspect of the only specimen of his new species *Coriocella nigra*: no measurements and few chacteristics of the dorsum and no mention of dorsal bosses. Probably he received this mollusc a certain period after its capture. Possibly the fragile internal shell was fractured or dissolved in the preservative solution. The holotype received from Paris enclosed no shell, but had a penis and a radula which were conform to the collected specimens and to the specimens received from Berlin. The picture of specimen N° 7 (Table 1, Fig. 11) taken after about 110 years of conservation, better illustrates the delineations of the three dorsal bosses than the pictures from 1994.

#### **C**ONCLUSIONS

The five live specimens collected (Nos 1–5) had three prominent dorsal bosses on one line perpendicular approximately in the middle of the length axis. The decrease of the volume of the bosses soon after the death of the animals is illustrated. Four specimens from Réunion have the same external aspect as the four specimens from Mauritius. The fact that soon after the death in this species the three dorsal bosses do not remain has caused confusion in the taxonomy of the Lamellariidae.

### CHELYONOTUS TONGANUS, QUOY & GAIMARD, 1832 - INTRODUCTION

During the voyage with L'Astrolabe, Quoy & Gaimard (1832) visited successively Réunion and Mauritius in the Indian Ocean and Tonga in the South Pacific. In their publication these authors declared to have captured the same mollusc on these three different islands. The description mentioned: "Le sigaret de Tonga a des larges tubercules...et un pied brun rouge assez vif". A drawing of the dorsal side is not published and there is no mention of bosses. In 1874 Prof. Mobius captured on Fouquets-Riff (Mauritius) two Lamellariidae considered by Bergh (1886) as related in general form to Chelyonotus semperi except for its five clearly distinct dorsal bosses. Bergh saw only the indication of one dorsal bosse although Prof. Mobius believed he had seen the indication of three dorsal bosses.

#### REDESCRIPTION OF CHELYONOTUS TONGANUS

During our stay in Tonga (February 1996) my wife and I collected two specimens on Fafa island and three on Pangaimotu island. These specimens were collected while snorkeling on the fringing reefs at a depth between 1 and 2.5 m during the day. Table 3 gives the tabulated information on the five specimens after one day preservation in alcohol; they are ranked according their lengths. N° 1 is used for the description; N° 4 has a fractured shell.

This gastropod is conspicuous by its black color when moving on a sandy bottom. Several times we mistook it for *Ovula ovum* (L., 1758). Although only one of our specimens was found on the sandy bottom the others were hidden between coral formations. The general form of the living animal is ovoid. The general coloration is black, the foot included. The complex of the five bosses is situated closer to the proximal end than

TABLE 3
Tabulated information of five specimens of *Chelyonotus tonganus* 

Specimen		Animal		Fo	ot	Shell
N°	Length	Breadth	Height	Length	<b>Breadth</b>	Diameter
1	82	50	40	24	6	28
2	64	43	34	31	7	33
3	58	40	30	20	8	18
4	54	44	36	22	8	30
5	52	32	30	14	10	19

Sex: Nos 1–2 are females; Nos 3–5 are males.

All measurements were made with callipers and are given in mm. The internal shell was measured on X-Ray photographs.

towards the tail. The bosses are rounded and not very prominent. The central boss is the largest and the bosses in the front are less voluminous than those in the rear.

The bosses are in contact and as a complex they do not move separately from the back. There are polygonal fields on the dorsal parts of the mantle (Figs 13–14). Soon after the death the bosses of *Chelyonotus tonganus* diminish in volume and only their markings remain.

For the study of the penis, the jaws, the radula and the shell we used specimen N° 4. The form of the penis (Fig. 17) is sickle-shaped. Its measurements are: length 12 mm, width from 2 to 3 mm. Its distal end points freely into the mantle cavity. In 1931 Thiele wrote that *Coriocella nigra* Blainville, 1824 is a synonym for *Chelinotus* Swainson, 1840 and for *Chelyonotus* Bergh, 1853 because their male duct is enclosed in their body wall.

The jaws (Fig. 18) are saddle-shaped with a length of approximately 3 mm and a width of approximately 2 mm. The radula (Fig. 19) has a length of 40 mm and a width of 1.5 mm. There are 20 teeth rows for 10 mm radula length. The radula is asymmetrical with an angle of approximately 20 between the base of the rachidian and the line perpendicular to the length axis of the radula. The formula of this reduced taenioglassate radula is 0-1-1-1-0. The rachidian (Fig. 20) has a base with a length of 400  $\mu$ m and a height of 480  $\mu$ m. The right leg is more developed. Both sides of the top (Fig. 21) bear about 10 denticles. The lateral teeth (Fig. 22) have a length of 1 mm with a maximum width of 400  $\mu$ m. There are approximately 20 denticles on the exterior side of the "canine protuberance" and 10 on the interior side.

For the shell see the description of the shell of Coriocella nigra.

#### **DISCUSSION**

Distinction from *Chelyonotus semperi* is obvious. *C. semperi* is ellipsoid (Table 4) and the five bosses are small, cylindriform and separated from each other. They are situated in the middle of the dorsum on a plateau that can rotate independently from the movements of the foot (pl. 8, Fig. a; Wellens 1991). After death the bosses do not change in size. Quoy & Gaimard suggest that the shell of the lamellariid species found in Tonga has a stronger spire than other Lamellariidae. This observation is not substantiated by these studies. The shells of four species are illustrated: *Coriocella hibyae* Fig. 23A; *Coriocella nigra* Fig. 23B; *Chelyonotus tonganus* Fig. 23C, and *Chelyonotus semperi* Fig. 23D.

#### **C**ONCLUSIONS

There has been much confusion in the description of the dorsum of Coriocella nigra and of Chelyonotus tonganus because de Blainville and his contemporaries Quoy & Gaimard did not observe the living animals. From field observations it is seen that the volume of the bosses can change drastically after death over short time spans. By coincidence, Bergh (1886) clearly described Chelyonotus semperi whose five dorsal bosses remain after the death. However, he did not recognise Coriocella nigra when Prof. Mobius asked his opinion about two specimens of Mauritian origin; he also considered Chelyonotus tonganus as "a minor variability" of Chelyonotus semperi. This author used the later descriptive name Chelyonotus for Coriocella and wrote in 1886 "This genus is until now composed of two species, if these are really specifically different: Chelyonotus semperi Bergh from the Indian Ocean and the Philippines and Chelyonotus tonganus from the Indian Ocean". I described after observation of the living animals, a species with remaining dorsal bosses (Coriocella hibyae 1991) and a species where the dorsal bosses disappeared soon after death (Coriocella jayi, 1994). Imitating the "Voyage de l'Astrolabe" we travelled consecutively to Réunion, Mauritius and Tonga: each time we found living specimens: Coriocella nigra with three bosses in the Indian Ocean and Chelyonotus tonganus with five bosses in the South Pacific. In both species the bosses disappeared soon after the death. The hypothesis that the number of dorsal bosses and their configuration is specific in the family of the Lamellariidae is strengthened by obvious differences in the corresponding radulae. Evidence is presented here to show that Coriocella nigra, Chelyonotus tonganus and Chelyonotus semperi are specifically different. This conclusion is summarized in Table 4, giving information on the general form and on the location of the dorsal bosses. Table 5 summarizes the differences of the corresponding radulae.

TABLE 4
General form and characteristics of the dorsal bosses of three species of Lamellariidae.

Species and locality	General form	Bosses number form at	ter death	Refs.
Coriocella nigra de Blainville 1825 Réunion, Mauritius	spool shaped proximal end more pointed	three; round, on a line perpendicular to the length axis in the middle of the dorsum	NO	2/3/4
Chelyonotus tonganus Quoy & Gaimard 1832 Tonga, South Pacific	ovoid proximal end more rounded	five; round not prominent near proximal end	NO	5
Chelyonotus semperi Bergh, 1866 Indian Ocean, Philippines	ellipsoid proximal end more pointed	five; cylindriform; on a plain in the middle of the dorsum	YES	1

The three species have mantle fields and a black colour.

TABLE 5
Summary of the characteristic of the middle third of the radulae of three species of Lamellariidae.

Species	Specimen length		adula Breadth (mm)	Rows of teeth per 10 mm
C. nigra	43 mm	15	0.9	40
Ch. tonganus	54 mm	40	1.5	20
Ch. semperi	55 mm	20	1.2	40

#### TABLE 6

Summary of the characteristics of the Rachidian and the lateral tooth of the radulae of three species of Lamellariidae.

Species	Rachidian		Lateral tooth				
	Height (µ)	Breadth(µ)	N° of dent	Height(µ)	Breadth(µ)	N° of	f denticles
						exter	inter
C. nigra	275	262	4	723	235	20	7
Ch. tonganus	480	400	10	1000	400	20	10
Ch. semperi	257	215	10	722	223	20	6

#### **ACKNOWLEDGEMENTS**

I am indebted to Dr J. Van Goethem (R.B.I.N.S.) for providing me with working facilities and for supervising this study. Thanks are further due to Dr P. Bouchet (Museum National d'Histoire Naturelle Paris) and to Prof. Kilias (Museum fur Naturkunde der Humboldt Universitat zu Berlin) for the loan of specimens. I thank my wife I. Hiby for procuring several specimens and for the drawings of the animals. For technical help thanks are due to Mr J. Cillis (R.B.I.N.S.) and to Mr H. Van Paesschen (R.B.I.N.S.). Finally I am indebted to Dr J. Van Goethem and Dr T. Backeljau for commenting on the manuscript.

#### REFERENCES

Bergh R. 1886 Reisen im Archipel der Philippinen von Dr. C. Semper Zweiter Band: Malacologische Untersuchungen von Dr R. Bergh. C.W. Kreidel's Verlag, Weisbaden, pp. 377–645.

DE BLAINVILLE H. 1825 Manuel de Malacologie et de Conchyliologie F.G. Levrault, Paris & Strasbourg, 647 pp.

CUVIER G. 1850 Le Regne Animal Fortin, Masson et Cie, Paris 266 pp., 139 pls.

HERMANNSEN A.N. 1846 Index Generum Malacozoorum Casselis. Sumptibus & Typis Theodori Fisheri, 221 pp.

Martens E. 1880 *Die Mollusken der Maskarenen und Seychellen* Verlag der Gutmann'schen Buchhandlung, Berlin, 168 pp., pls. 169–176.

Quoy J.R.C. & Gaimard J.P. 1832 Voyage de L'Astrolabe Tome Second. J. Tastu, Paris, 320 pp.

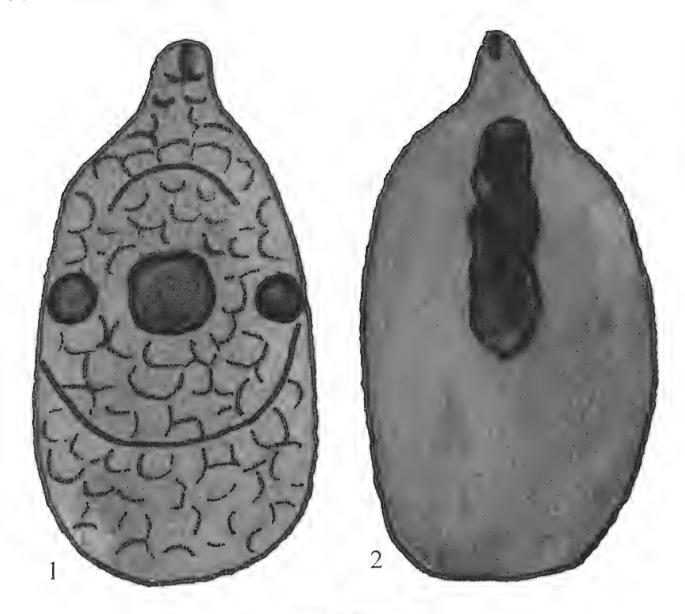
SWAINSON W. 1840 A Treatise on Malacology Longmans, Orme, Brown, Green Longman & Taylor, London.

THIELE J. 1931 Handbuch der Systematischen Weichtierkunde Jena. G. Fischer Verlag, 778 pp.

TRYON G.W. Jr. 1886 Manual of Conchology Vol. 8 G.W. Tryon, Jr, Philadelphia, 461 pp., 79pls.

Wellens W. 1991 *Coriocella hibyae* sp. n. A new *Lamellaria* species (Gastropoda Prosobranchia) from the Republic of the Maldives *Journal of Conchology* **34**: 73–80.

Wellens W. 1995 *Coriocella jayi* sp. n. A new Lamellarid species (Gastropoda:Prosobranchia) from Réunion and Mauritius. *Journal of Conchology* **35**: 369–376.



Figs 1 & 2 Drawing of Coriocella nigra, the living animal (specimen N° 1, Table 1).

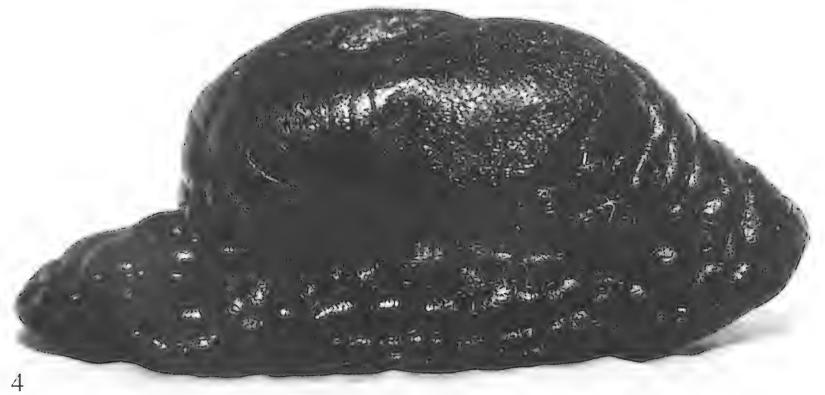
Fig. 1 dorsal view Fig. 2 ventral view

Figs 3 & 4 Photographs of Coriocella nigra after death.

Fig. 3 dorsal view

Fig. 4 lateral view







**Fig. 5** SEM of the penis of *Coriocella nigra*. Scale bar = 1 mm.



Fig. 6 SEM of the jaw of *Coriocella nigra*. Scale bar = 1 mm.



Fig. 7 SEM of part of the radula of *Coriocella nigra*. Scale bar = 1 mm.



Fig. 8 SEM of the rachidian of Coriocella nigra. Scale bar =  $100 \mu m$ .



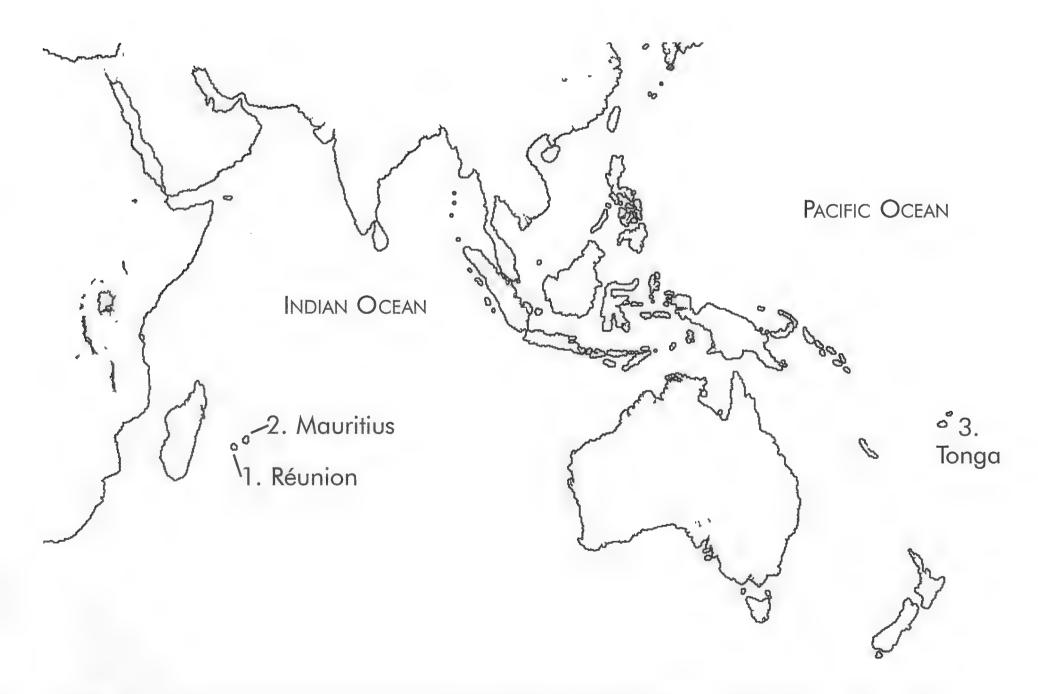
Fig. 9 SEM of the lateral tooth of *Coriocella nigra*. Scale bar =  $100 \mu m$ .



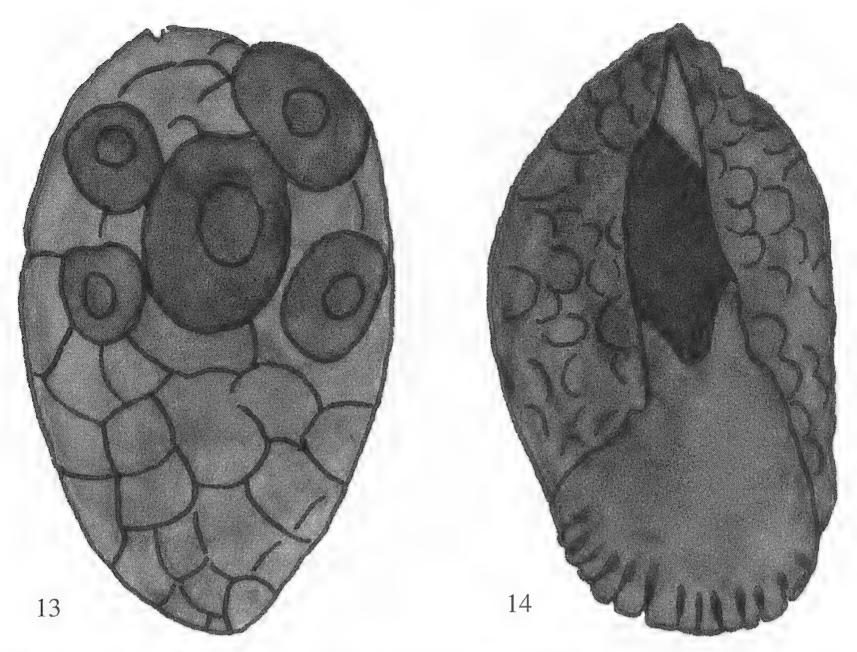
Fig. 10 SEM of the top of lateral tooth of *Coriocella nigra*. Scale bar =  $100 \mu m$ .



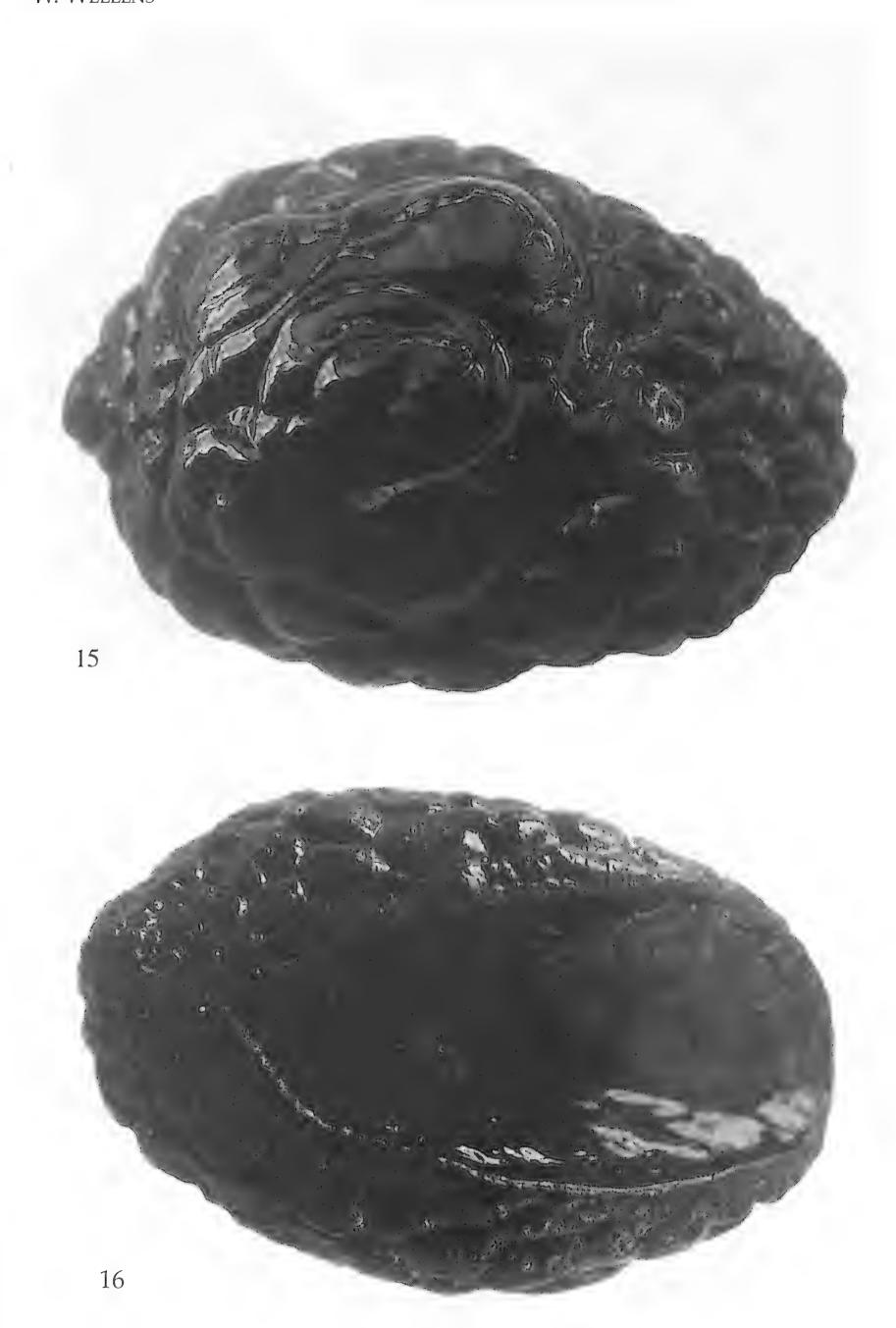
Fig. 11 Photograph of *Coriocella nigra* specimen N°7 demonstrating the delineations of the dorsal bosses.



**Fig. 12** Geographical location of *Coriocella nigra* (1 Réunion, 2 Mauritius) and *Chelyonotus tonganus* (3 Tonga).



Figs 13 & 14 Life size drawings of *Chelyonotus tonganus* (specimen N° 1, Table 3). With indications in dotted lines of the position of the internal shell. 13 dorsal view 14 ventral view



Figs 15 & 16 Chelyonotus tonganus Quoy & Gaimard, 1832. Photographs of the specimen N° 1, Table 3. The animal 1 hour after capture. Fig. 15 dorsal view Fig. 16 ventral view.



Fig. 17 SEM of the penis of *Chelyonotus tonganus* specimen  $N^{\circ}$  4, Table 3. Scale bar = 1 mm.



Fig. 18 SEM of the jaw of *Chelyonotus tonganus* specimen  $N^{\circ}$  4, Table 3. Scale bar = 1 mm.

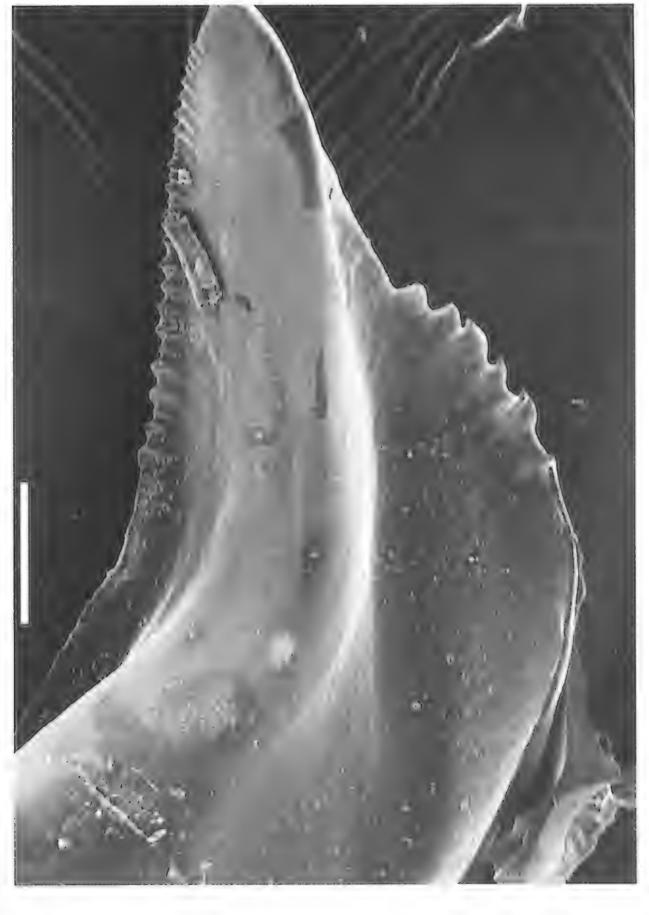


Fig. 19 SEM of part of the radula of *Chelyonotus tonganus* specimen  $N^{\mu}$  4, Table 3. Scale bar = 1 mm.



Fig. 20 SEM of the rachidian of *Chelyonotus tonganus* specimen  $N^{\circ}$  4, Table 3. Scale bar = 100  $\mu$ m.





**Fig. 21** SEM of the top of rachidian of *Chelyonotus tonganus* specimen N° 4, Table 3 Scale bar = 100 μm.

**Fig. 22** SEM of the top of lateral tooth of *Chelyonotus tonganus* specimen N° 4, Table 3 Scale bar = 100 μm.

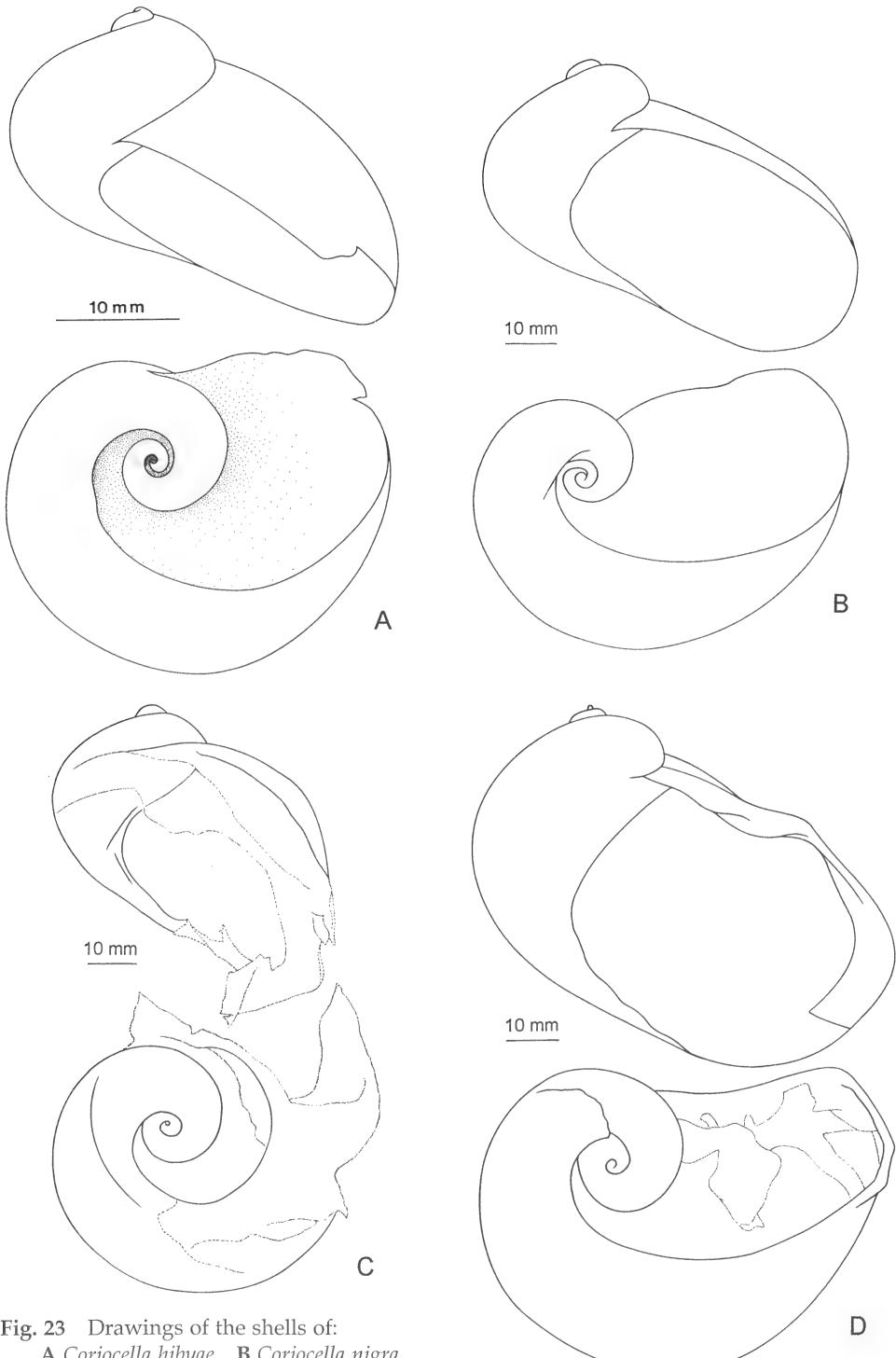


Fig. 23 Drawings of the shells of:

A Coriocella hibyae B Coriocella nigra C Chelyonotus tonganus. D Chelyonotus semperi

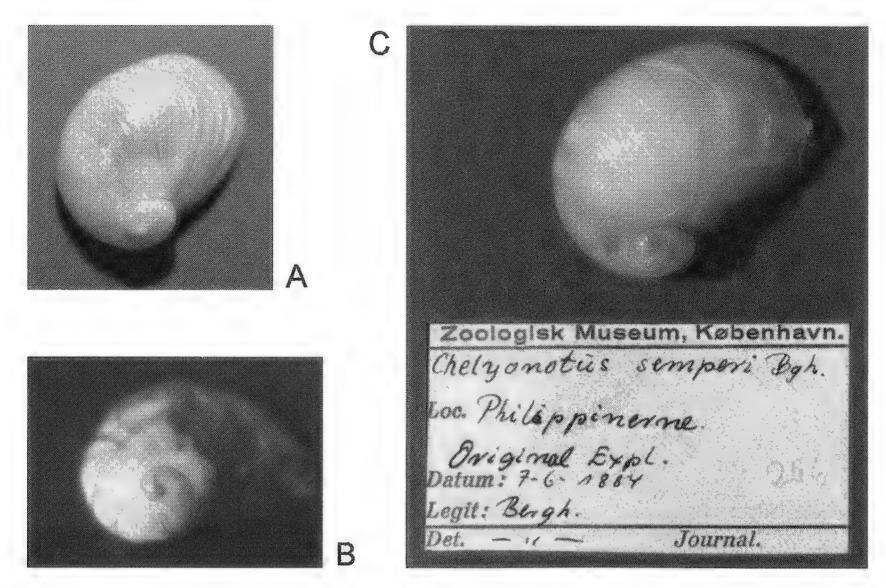


Fig. 24A–C Photographs of the spire of the shell of:

A Coriocella nigra B Chelyonotus tonganus C Chelyonotus semperi.

·		

## NEW NAMES FOR FOUR SPECIES OF THE GENUS TURBONILLA (GASTROPODA, HETEROBRANCHIA, PYRAMIDELLIDAE)

Turbonilla zulmae nom. nov., T. sinense nom. nov., T. vix nom. nov. and T. nesiotes nom. nov. are respectively, proposed for, T. elongata Castellanos, 19821, T. stricta Clessin, 19022, T. hemphilli Bartsch, 1917<sup>3</sup> and T. abrupta Clessin, 1902.

The genus Turbonilla Risso 1826, is well represented in all oceans, both in temperate and tropical regions. Yet, the correct taxonomic status of its species is very complex and only for the European species is there a comprehensive synthesis (Aarsten, 1981<sup>4</sup>).

Our efforts to identify specimens of the genus from the Brazilian coast, led us to find

that:

T. elongata Castellanos, 1982 (p. 66, fig. 8) is preoccupied by T. elongata Pease, 1967<sup>5</sup> (p. 293, pl. 24) so we propose the name *T. zulmae* for *T. elongata* Castellanos *non* Pease, in honor of Dr. Zulma Ageitos de Castellanos;

T. stricta Clessin, 1902 (p. 168, pl.35) is preoccupied by T. stricta Verrill, 1873, so we

propose the name *T. sinense* for *T. stricta* Clessin *non* Verrill;

T. hemphilli Bartsch, 1917 (p. 646, pl. 44) is preoccupied by T. hemphilli Bush, 1899 (p.

169, pl. 8) so we propose the name T. vix for T. hemphilli Bartsch non Bush;

T. abrupta Clessin, 1902 (p. 166, pl. 29) is preoccupied by T. abrupta Bush, 1899 (p. 168, pl. 8) which is synonym junior of *T. levis* C.B. Adams, 1850 (Jong & Coomans, 1988<sup>7</sup>), so we propose the name *T. nesiotes* for *T. abrupta* Clessin *non* Bush.

Aknowledgements to the Academy of Natural Sciences of Philadelphia and to CNPq. (Conselho Nacional de Desenvolvimento Científico e Tecnológico) for partially supporting this study.

- <sup>1</sup> Castellanos Z.J.A. 1982 Communicaciones del Museu Argentino de Ciencias Naturales Bernardino Rivadavia 7: 61-85.
- <sup>2</sup> CLESSIN S. 1902 In: KÜSTER H.C. & KOBET W. Systematisches Conchylien-Cabinet von Martini und Chemnitz.
- <sup>3</sup>Bartsch P. 1917 Proceedings of the United States National Museum **52** (2193): 637–681.
- <sup>4</sup> Aarsten J.J.V. 1981 Bolletino Malacologico 17 (5–6): 61–68.
- <sup>5</sup> Pease W.H. 1867 American Journal of Conchology III: 271–297.
- <sup>6</sup>Bush J.K. 1899 Proceedings of the Academy of Natural Sciences of Philadelphia **51**: 145–177.
- <sup>7</sup> JONG K.M. & COOMANS H.E. 1988 Marine Gastropods from Curacao, Aruba and Bonaire. E. J. Brill, Leiden.

A.D. Pimenta<sup>1</sup> & R.S. Absalão<sup>2</sup> Dept°. de Zoologia, Instituto de Biologia, Universidade Federal do Rio de Janeiro, Av. Brigadeiro Trompowsky, s/n - CEP 21941-570. Ilha do Fundão, RJ,

Brasil.

<sup>&</sup>lt;sup>1</sup>Pós-Graduação em Zoologia

<sup>&</sup>lt;sup>2</sup>Dept°. de Biologia Animal e Vegetal, Inst. de Biologia, Universidade do Estado do Rio de Janeiro.

## LATE QUATERNARY LAND SNAILS FROM THE SOUTHWESTERN BALTIC SEA

Following the last deglaciation, the Baltic Sea has experienced a dynamic history<sup>1</sup>. In the southwest, the rise of the sea level has surpassed the rise of the land, and deposits from former stages of the Baltic Sea are found below the present sea level. Large areas that are now below sea level have been dry land for certain times during the Late Glacial and early Postglacial, from c. 13 to 8 ka BP (ka = kiloannua = 1000 radiocarbon years, BP =

before present).

During the past years, macrofossil analyses have been performed on a number of cores collected by the Geological Survey of Denmark and Greenland and by the Institut für Ostseeforschung, Warnemünde. Two of these cores yielded remains of terrestrial gastropods, several of which are of interest from an ecological and zoogeographical point of view. Core MB 01/94 from Mecklenburg Bay (54°22.29′ N, 11°45.10′ E) was taken at a water depth of 23.2 m. Land snails were abundant in a layer of fine sand 66-76 cm bsf, but rarely occurred down to 180 cm bsf. The lower part of the sequence with gastropods is dated to 9.7 ka BP, the middle part to 9.5 ka BP, and the upper part is undated, but probably only slightly younger. Core 560008 comes from a position east of Gedser (54°32.12′ N, 12°12.48′ E). The snails were found in a sandy layer at 390–398 cm bsf. This sand layer is correlated with deposits in a nearby core dated to the Younger Dryas chronozone (11–10 ka BP). The water depth at the coring site is 17 m.

In the following sections, the data concerning the species' geographical range and habitats are based on Ložek (1964)<sup>2</sup> and partly on Kerney *et al.* (1983)<sup>3</sup>, and the information concerning the species' quartenary appearance in Sweden mostly on Waldén (1986)<sup>4</sup>.

In the core MB 01/94 four taxa were identified:

Cochlicopa nitens (Gallenstein) - 1 specimen. C. nitens is a rare species with a predominantly Central-Eastern European distribution. Isolated and scattered occurrences are known from Southern Sweden, Denmark, Germany, Poland, Czech Republic, Slovakia, Hungary, Austria and Switzerland. C. nitens is a stenotopic, calciophilous species, living in rich wet forests, fens and marshes. It survived the Weichselian in situ in Central Europe and belongs to a group of species that first appeared in Southern Sweden (Scania) in Preboreal or Early Boreal time.

Zonitoides nitidus (O.F. Müller) - About 45 shells and c. 15 fragments. The geographical range of Z. nitidus is Holarctic, and the species is widespread in Northwestern Europe, although absent from arctic areas. The species is characteristic of lake and river margins, wet forest types, fens and other very moist habitats. It survived the Weichselian in situ in Central Europe and has been found in Preboreal-Early Boreal strata in Scania.

Cf. Deroceras sp. - One internal shell of a Limacidae was found in core MB 01/94, 66–76 cm bsf.

Euconulus alderi (Gray) - 3 specimens. E. alderi is widespread in Northern, Western and Central Europe. It is hygrophilous and typical of moist and wet habitats, especially marshes. As C. nitens and Z. nitidus, it survived the Weichselian in situ in Central Europe and occurs in Preboreal-Early Boreal strata in Scania.

Landsnail communities with these three species represented, are today to be found in calcareous marsh habitats or in rich wet deciduous forests in the Swedish provinces of Skåne (Scania), Gotland and Uppland and in Western Denmark (Sjælland). The dating of the sample fits well with the species' first occurrence in Southern Sweden (Preboreal-Early Boreal), a time when suitable habitats successively became available in the area, following the abrupt temperature rise at the Younger Dryas - Preboreal boundary.

65

In the core 560008 two taxa were identified:

Columella columella (Martens) - One fragment. The present distribution of *C. columella* is arctic and alpine. The species occurs in the mountains of Scandinavia, in the Alps and in the Carpathians. *C. columella* lives in calcareous marshes with cold springs and in wet calcareous subalpine forests. It may also be found on wet, mossy rocks and, under more dry conditions, in *Dryas octopetala*-heaths. It survived the Weichselian *in situ* in Central Europe and occurs in Preboreal-Early Boreal strata in Scania.

Vertigo genesii (Gredler) - 3 specimens. The present geographical range of this very rare species can be characterised as boreo-alpine. The main distribution area is the Scandinavian mountains, with a few scattered occurrences in the Alps, in the Carpathians and one in Northern England. In Middle and South Sweden there are a few relict-like occurrences in calcareous fens with cold springs. V. genesii is a pronounced stenotopic calciophile, characteristic of cold calcareous fens. In Southern Sweden it occurs as a late Weichselian immigrant, found in strata from the Allerød interstadial (11.8–11 ka BP).

Suitable habitats for these two species are today found in the Scandinavian mountains where they, very often together, inhabit wet calcareous habitats. The sample is dated to Younger Dryas and at this time *V. genesii* had already advanced northwards, as shown by its occurrence in strata from the Allerød interstadial in Scania. *C. columella*, however, occurs later here, in Preboreal-Early Boreal strata. During Younger Dryas suitable habitats, with *C. columella* and *V. genesii* as typical landsnail elements, were probably common in the tundra landscape covering Southern Scandinavia and parts of the present Southern Baltic Sea.

Ted von Proschwitz Natural History Museum, Box 7283, S-402 35 Göteborg, Sweden Ole Bennike Geological Survey of Denmark and Greenland, Thoravej 8, DK-2400 Copenhagen NV, Denmark

# A SMALL CONTRIBUTION TO THE ANATOMY OF TROCHONANINA (UROCYCLIDAE, TROCHONANINAE)

On 7th November 1962 I found a considerable number of specimens of *Trochonanina elatior* (von Mts.) on garden plants in the City Park, Nairobi, Kenya, an area which had been under natural dry evergreen forest earlier this century and some of which still remained. The species occurred together with *Krapfiella mirabilis* Preston. Dissections I made of freshly drowned specimens of the *Trochonanina* remained unpublished but since the anatomy of this species has not been described it seems worthy of record.

The shells of the specimens examined were very uniform, measuring 15.5 x 11 mm; protoconch with fine spiral sculpture, the rest of the whorls with very fine transverse striae above and the base with very fine spiral, striae. *T. elatior* differs from *T. mozambicensis* in the shell being more elevated with the transverse sculpture much closer; it also occurs at higher altitudes. Animal 25 mm long with caudal appendage 4 mm long; body white, save for brown caudal area and appendage, grey-brown head and neck flanks

<sup>&</sup>lt;sup>1</sup> BJÖRCK S. 1995 Quat. Internat. **27**: 19–40.

<sup>&</sup>lt;sup>2</sup> LOZEK V. 1964 Quartärmollusken der Tschechoslowakei. Rozpr. Úst. geol. 31 374 pp.

<sup>&</sup>lt;sup>3</sup> KERNEY M.P., CAMERON R.A.D. & JUNGBLUTH J.H. 1983 Die Landschnecken Nord- und Mitteleuropas Paul Parey, Hamburg/Berlin 384 pp.

<sup>&</sup>lt;sup>4</sup> Walden H.W. 1986 Malak. Abh. Staatl. Museum Tierk. Dresden 11(10): 105–133.

and top of neck brown; mantle white, heavily marked with blackish in front and brown behind. The anterior parts of the genitalia are shown in Fig. 1. When comparisons are made with other species it must be born in mind the material was fresh and not shrunken by fixation in alcohol. The right ocular retractor muscle passes between the male and female ducts. The radula formula is 39:1:12:c:12:1:39 with the narrow marginals having the accessory cusp distant from the main cusp thus confirming a previous examination (Verdcourt, 1961¹) although in that specimen I gave the formula as 22:11–13:10:c:10:11–13:22. The anatomy is very similar to that of *T. mozambicensis* (Verdcourt, 1961) the type species of the genus (Connolly 1942²)\* save for the shorter vagina and the marginal radular teeth having the cusps more approximate and pincer-like in *T. mozambicensis*.

Godwin-Austen's and Semper's accounts of the anatomy of Trochonanina

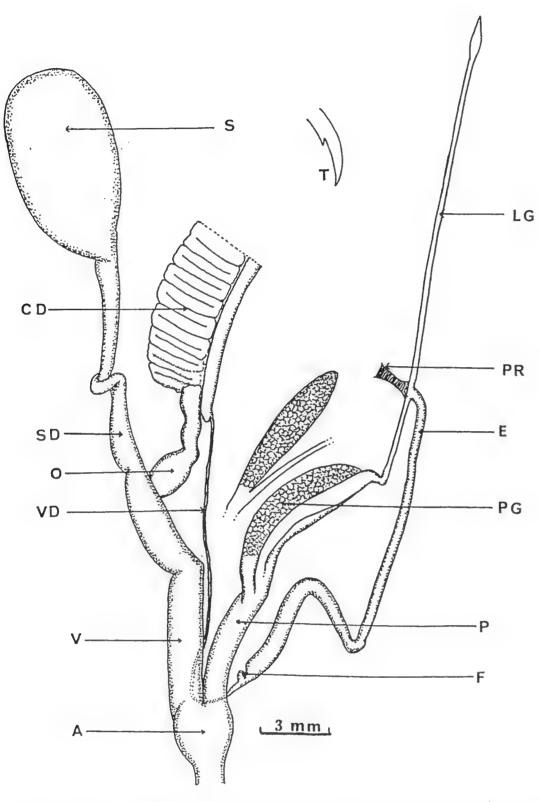
E.A. Smith handed over to Godwin-Austen some Trochonanina preserved in spirit collected by J.W. Gregory during his expedition to Kenya (Smith, 1894<sup>3</sup>; Gregory, 1896<sup>4</sup>). Godwin-Austen (1895)<sup>5</sup> reported on the dissection of this material under the name Martensia mozambicensis and gave two figures of the genital organs, one showing no penial gland and the other depicting such an accessory organ. Semper (1870)6 who erected the genus Martensia for Helix mozambicensis also depicts a penial gland. It is certain that Godwin-Austen had at least two species from the Gregory collection in spirit and his statement that the species varies much in height is in itself suggestive. Although the spirit material appears to be no longer extant, the shell material is still preserved in The Natural History Museum and confirms that Godwin-Austen included three different species under the name mozambicensis none actually matching the type of that species. It must be admitted, however, that each was identified as mozambicensis 'var'. Only one lot actually has a label referring to spirit material, but presumably one or both of the others also had accompanying spirit material although the dry shells do not look as if they have ever been in spirit. Accession 93.12.22.26 was collected near Lugard Falls (3°02'S, 38°42' E) on the Sabaki R. (sometimes called the Galana R.) west of camp 109 on 8th August 1893. The single shell resembles Trochonanina crassiplicata (Preston) but is most unlikely to be conspecific since the type comes from Mt. Kenya in very different vegetation and all known material is from a much higher altitude. T. crassiplicata is known anatomically and characterised by a long, very convoluted penis when dissected out; it does lack an obvious external penial gland but has differently positioned penial retractor muscles from that depicted in either of Godwin-Austen's drawings (Verdcourt, 1961). Accession 93.12.22.72–3 (as 'Helix 2') was collected at Kibwezi (2°24'S, 37°57.5'E) and the two shells show spirit damage and the label mentions that spirit material was collected. It appears to be *Trochonanina pyramidea* von Mts. and material I have dissected from much the same area has lacked an external penial gland (Verdcourt, 1961). The third lot has very confusing labels; one states 'Gregory 1893 camp 68 coll. no. XXXIV 10 June Alng'aria' (given by Gregory (1896) as 36°20'E, 0°10'N which is in Laikipia near Marmanet); another 'shores of Lake Elmenteita (0°26.5'S, 36°15'E) coll. no. XLV', considerably further south. But there are other labels, one old one gives 93.12.22.65.36 as the accession number and Connolly's new label gives 93.12.22.57-8 and the determination T. levistriata (Preston) which is correct, the tube containing one adult and one juvenile. Reference to the accessions book gives 56–9 as *Vitrina* so the label is an error; 36 is given as from Alng'aria and 65–6 as Trochonanina 1, Helix 1, shores of Lake Elmenteita. Unfortunately Gregory (1896) mentions no mollusca nor camp or collection numbers. I do not appear to have dissected *T. levistriata* so do not know whether the penial gland is obvious or not.

There are no such complications about Semper's material which was collected at Tette (Tete), Mozambique by W.C.H. Peters and clearly part of the original lot from which Cuming obtained the shells described by L. Pfeiffer as *Helix mozambicensis* and who

<sup>\*</sup> Nevill's choice of *Helix mozambicensis* as the type of *Trochonanina* Mousson was long overlooked and *Martensia* used for the African species but this was found to be preoccupied (Iredale 1914<sup>7</sup>) after which Bourguignat's genus *Ledoulxia*, based on a variety of *T. mozambicensis*, was then used.

gives the same provenance.

I am grateful to Dr F. Naggs for help in refinding Gregory's material which I had not been able to retrace although I had examined it many years ago.



A = atrium

CD = common duct

E = epiphallus

F = flagellum

LG = lime gland

O = oviduct

P = penis

PG = penial gland

PR = penial retractor

S = spermatheca

SD = spermathecal duct

T = part of marginal tooth

V = vagina

VD = vas deferens

Fig. 1 Part of genital ducts of Trochonanina elatior (von Mts.)

B. Verdcourt Royal Botanic Gardens Kew Surrey UK

<sup>&</sup>lt;sup>1</sup> Verdcourt B. 1961 *J. de Conch. Paris* **101**: 120–134.

<sup>&</sup>lt;sup>2</sup> CONNOLLY M. 1942 *J. Conch.* **21**: 328–335.

<sup>&</sup>lt;sup>3</sup> SMITH E.A. 1894 *Proc. Malac. Soc.* 1: 163–168.

<sup>&</sup>lt;sup>4</sup>Gregory J.W. 1896 The Great Rift Valley London.

<sup>&</sup>lt;sup>5</sup> GODWIN-AUSTEN H.H. 1895 *Proc. Malac. Soc.* 1: 281–287.

<sup>&</sup>lt;sup>6</sup> SEMPER C.G. 1870 Reisen im Archipel der Philippinen. Wiesbaden. 3: 42, T. 3, Fig. 5. T. 6, Fig. 15.

<sup>&</sup>lt;sup>7</sup>IREDALE T. 1914 *Proc. Malac. Soc.* **11**: 120–122.

### **REVIEW**

The Systematics and Evolution of Littorina by David G. Reid, The Ray Society, 1996. ISBN O 903874 26 1, pp. i–x, 1–463. Available from The Ray Society, c/o Intercept Limited, PO Box 716, Andover, Hants., SP10 1YG, UK. Phone (44)1264 334748, Fax (44)1264 334058, price £89 plus postage and packing (£6 in UK, £10 overseas). (Also available at concessionary prices to members of the Ray Society, the Conchological Society of Gt Britain and Ireland and the Malacological Society of London from Dr N.J. Evans, Honorary Secretary, The Ray Society, c/o Department of Zoology, the Natural History Museum, London, SW7 5BD)

The Ray Society has a history back to 1844 of publishing fine works on natural history with a special emphasis on the British Isles. This latest production is by David Reid of the Natural History Museum and is the latest (but I hope not the last) result of his studies in the Littorinidae which began in the early 1980s. It deals with 19 recent and 4 fossil species which he places in 4 subgenera of *Littorina - Liralittorina*, *Planilittorina*, *Littorina* ss, and *Neritrema -* together with 6 fossil species whose attribution is doubtful. The contents cover Material and Methods, Morphology, Systematic Descriptions,

Phylogeny, and Macroevolutionary History.

Littorina as defined in this publication is a fascinating genus, some members of which have received intensive study - and it still has secrets to unravel. Part of the reason for the interest taken in it must lie in Littorina species' accessibility as intertidal animals. But they have also proved to be very complex. There are different developmental strategies - planktotrophic and non-planktotrophic, the latter comprising the subgenus Neritrema and embracing oviparity and, in L. (N.) saxatilis only, ovoviviparity. Many species, especially in Neritrema develop ecophenotypes and geographical variants; some of the latter, this work strongly suggests, have their distribution controlled by crab predation or the lack of it. These features are overlaid by shell colour polymorphism and sometimes by the effects of sexual dimorphism and ontogeny. Populations within a species may show significant genetic separation which is sometimes observable within very short distances on the shore - again there are examples within L. (N.) saxatilis.

David Reid lucidly and painstakingly takes the reader through the maze of factors relevant to the study of *Littorina* and produces an account that makes sense, is comprehensive and critical in its overview of the mass of past work (up to 1996) on the genus, adds numerous new observations, and thoroughly revises the taxonomy and phylogeny of the genus, using new cladistic, biochemical, evolutionary and ecological analyses. At the same time he makes it clear what is not known and where further study is needed.

I could not think of any questions that he had at the least not considered.

The story that emerges, particularly from the chapters on Phylogeny and Macroevolutionary history, but also from the Systematic Descriptions is of a genus which originated possibly in the Paleocene, certainly before the Oligocene, in, probably, the north Pacific. About 10 million years ago, at a time of climatic cooling, it appears to have adapted to exploiting cool water shores dominated by macrophytic algae which resulted in a burst of speciation leading to its current diversity and importance in inter-tidal biotas. *L.* (*Littorina*) and *L.* (*Neritrema*) arrived in the Atlantic as a result of the trans-Arctic interchange of mollusca in the Pliocene. There is a loose end here, namely if the genus arose in the Pacific, why is *L.* (*Liralittorina*) striata regarded as the least developed living species, distributed only among Atlantic islands? David Reid offers two possibilities on pages 384–5.

Production of this book is excellent; the type is clear and easy to read and one cannot fault the well-placed and numerous photographs, text figures and tables. After much

effort I found one typographic error (for collectors of these it is on page 120). The only thing I did wonder about was the lack of any sort of subject index. It would be nice for instance to be able rapidly to find where illustrations of protoconchs are located or all the sections on development. But the book is very carefully structured and production of an index would have added to the cost, and to the time needed to produce it.

It is quite clear that this is going to be a standard work for a long time to come. David Reid is to be congratulated for producing it and for so deservedly winning the

Zoological Society of London's Gold medal for a scientist under 40.

The Systematics and Evolution of *Littorina* is throughly recommended for acquisition by anyone or any institution concerned not only with marine mollusca, but also with the

broader fields of speciation and adaptation in animals as a whole.

Finally, may I claim a very small and indirect personal involvement in this book. Among the fossil *Littorina* examined were those in my brother's collection which were collected by both of us in the 1950s. Figure 37D shows a specimen of *L. littorea* from Stratton Hall Levington. I have a notebook dating from [1954] which has a list of fossils from that site which includes *L. littorea* 

David Long



# OBITUARY - J.Z. YOUNG (1907–1997)

J.Z. Young was Professor of the Department of Anatomy, University College, London, from 1945 until his retirement in 1974. He was a Zoologist with no medical degree, known primarily for his published research on giant nerve fibres of squids; the medical establishment was outraged and opposed his appointment to the Chair at U.C. However, the medical establishment was wrong; University College had backed a winner. Over the next couple of decades J.Z. raised his Department of Anatomy to international status, a model for similar departments elsewhere. J.Z. held that while anatomy was undeniably critical, it was only a basis for wider investigations of how animals worked. For J.Z., biology was fascinating and the fascination extended all the way

from the minutiae of nerve connections (*The Anatomy of the Brain of* Octopus vulgaris, 1971) to consideration of the human condition (*Philosophy and the Brain*, 1987).

Boundaries within science were silly and he never paid any attention to them.

For most of his working life, J.Z.'s research centred on the question of learning - what goes on in the brain when behaviour changes as a result of experience. He chose to work on octopuses, probably as a result of early experience of these animals during his 1928–29 tenure of the Oxford Scholarship to Naples. Octopuses learned; they had brains that should prove simpler than man's. Over the next nearly fifty years he continued to pump out research on the nervous systems of octopus and its relatives, leaving several unfinished papers and a book, *The Brains and Lives of Cephalopods* (with Marion Nixon, who was his research assistant for many years) nearing completion when he died at the age of ninety; his heart couldn't keep up with his brain.

The pace had always been frenetic. Naples days started early, broke for a rush to Posillipo to swim at mid-day, and finished late, generally in Tonino's tiny wine-bar where discussion would continue while J.Z. consumed a quantity of alcohol, without visible effect, the envy of us less heroic members of the community. He took endless pains to help those following behind him. He could be rude about the work of his peers and impatient with anybody not adhering to his own high standards; but one never heard him say anything damaging behind the backs of scientists more junior than himself. J.Z. was a kind man, to everybody but time-wasters. The only people he had no time for at all were those who wished merely to register a meeting with the great man; visitors to the laboratory in Naples were sometimes brushed aside in a manner that doubtless came as a shock to anyone who imagined that the politics of science were as important as the research itself.

Between whiles (one wonders when, for a man engaged in full time research and running a large department) he wrote the remarkable series of textbooks on which a whole generation of us grew up. *The Life of Vertebrates* (1950) had a sweep, a clarity and a readability that showed just how well science could be summarised and explained by someone who really knew what he was doing. It was followed by *The Life of Mammals* (1957) and an *Introduction to the Study of Man* (1971) He was above all a teacher, believed

without question that people couldn't possibly not be interested in how animals worked and that it was the duty of any research worker to explain what it was all about.

Honours came his way. He was a very young FRS, a Reith lecturer for the BBC (*Doubt and certainty on Science*, in 1950), an honourary Fellow of the British Academy, an honourary Sc.D from Oxford, and, perhaps the award he valued most, an honourary Citizen of the City of Naples. Many people believe that he should have had a Nobel prize for his work on the giant fibres of squids, a 1930 discovery that formed the basis for our present understanding of how nerves work.

On 4th July 1997, J.Z. left his second wife, Raye, three children, a son and two daughters, numerous grandchildren and a large group of people whom he described, on his

ninetieth birthday, as his 'Scientific Children'. We miss him.

Dr Martin J. Wells Department of Zoology University of Cambridge

## **CORRIGENDA**

Luiz Ricardo L. Simone (1997) *Ammonicera plana* a new species of Omalogyridae (Gastropoda, Allogastropoda) from São Paulo coast, Brazil. *Journal of Conchology* **36 (1)**: 43–49.

#### FIGURE LEGENDS

**Figs 1–6** *Ammonicera plana* n. sp. SEM: 1 shell in left view, scale =  $100 \, \mu m$ ; 2 shell in right view, another specimen, scale =  $100 \, \mu m$ ; 3 operculum, outer view, scale =  $20 \, \mu m$ ; 4 specimens of Fig. 1 in frontal view, scale =  $100 \, \mu m$ , 5 and 6 variation of protoconch sculpture in two specimens, right view, scales  $20 \, \mu m$ , Fig. 5 is detail of Fig. 2.

Figs 7–12 Ammonicera plana n. sp. anatomy: 7 dissected specimen with mature capsule, lateral right view, foot and columellar muscle extracted, mantle deflected showing part of mantle cavity; 8 mantle cavity of the same, inner view; 9 lateral left view of anterior half of body whorl with locomotory, digestive and renal organs seen if the animal was transparent; 10 right view of shell showing colour patterns; 11 lateral right view with special reference to genital system, lateral region of gonad not drawn, pt seen by transparency of head tegument.; 12 dorsal view of extracted head with part of its tegument deflected showing inner haemocoel structures. Scales = 50 μm. Abbreviations: ag albumen gland; an: anus; ap anterior pedal gland; ca capsule; cg capsule gland; cl cephalic lobe; cm columellar muscle; da digestive gland; fr folded thickened mantle region; ft foot; he head tegument; ha hypobranchial gland; jw thickness of cuticle like jaws; ki kidney; lo large ova, mb mantle border; ma mucous gland; mo mouth; nr nerve ring; oaf odontophore; oe oesophagus; op operculum; ov ovarium, pp posterior pedal gland; pt large gland in posterior region of haemocoel (prostate?); re retina; rt rectum; te testis; ss sperm sac; st stomach.

Figs 13 and 14 *Ammonicera plana* n. sp. anatomy: 13 para-sagital section of anterior region of head-foot and mantle; 14 tangential-left section of end of pallial cavity of an immature specimen, anterior region at right. Scales =  $25 \mu m$  For abbreviations see Figs. 6–12.

### RECORDER'S REPORT: NON-MARINE MOLLUSCA

The following new vice-comital records have been verified since the last Report (*Journal of Conchology* **35** p. 528). Unless stated otherwise, all date from 1996-7.

Dorset (9): Leiostyla anglica, Melbury Sampford (31/5605), J. Hunnisett.

Sussex West (13): Pisidium pseudosphaerium, Amberley Wild Brooks (51/0314), M.J. Willing.

Middlesex (21): Toltecia pusilla, Highbury (51/3186), Jane Reynolds.

Glamorgan (41): Cochlicella barbara, Kenfig Burrows NNR (21/7882), Janet Boyd.

Dumfries (72): Planorbis carinatus, Lochmaben Castle (35/0881), T. Huxley, 1995.

Kirkcudbright (73): Lymnaea stagnalis, Auchenreoch Loch (25/8271), T. Huxley, 1991; Planorbarius corneus, White Loch, Rockcliffe (25/8654), T. Huxley, 1995.

Lanark (77): Succinea oblonga, Cleghorn Glen (26/9045); Vertigo pusilla, Balea perversa, Fiddler Glen, Crossford (26/8446); Ashfordia granulata, Bothwell Castle (26/6858), all B. Colville.

Haddington (82): Milax budapestensis, Haddington (36/5173; garden), A.T. Sumner.

**Linlithgow** (84): *Milax budapestensis*, Faucheldean (36/0874; garden); *Limax maculatus*, *Deroceras caruanae*, Linlithgow (26/9976; garden), all A.T. Sumner.

Stirling (86): Planorbis carinatus, Union Canal, Polmont (26/9378), T. Huxley, 1990.

Forfar (90): Lymnaea stagnalis, Crombie Reservoir (37/5240), T. Huxley, 1995.

Westerness (97): Vertigo pygmaea, Inverroy (27/2582), B. Colville. Kintyre (101): Gyraulus laevis, Taynish (16/7385), T. Huxley, 1994.

**Ebudes South** (102): *Valvata cristata, Pisidium milium,* Ballimartin, Islay (16/3665); *Vertigo geyeri,* Loch Finlaggan, Islay (16/3766); *Vertigo lilljeborgi,* Loch Fadda, Islay (16/4163); *Candidula intersecta,* Loch Gruinart, Islay (16/2973), all M.J. Willing.

The most important find of the past year is undoubtedly Dr Willing's discovery of *Vertigo geyeri* on Islay, complementing the first discovery of the species in Scotland (Perthshire) by Dr Colville in 1995. On Islay it was found in two mossy calcareous flushes with a low-growing vegetation of *Schoenus nigricans* and other sedges—a habitat typical for this rare *Vertigo* in the British Isles. The presence of *Vertigo lilljeborgi* on Islay is also noteworthy.

Among Dr Colville's new records for Lanarkshire (still a badly under-recorded county) *Succinea oblonga* and *Vertigo pusilla* are of the most interest, the latter confirming a vague 19th century report from the same general area. The habitats of both species are valley woodland. *Leiostyla anglica* from Dorset also substantiates a Victorian record from a few miles away (Wootton Glanville, 1878).

Pisidium pseudosphaerium has been identified from a marsh drain in Amberley Wild Brooks, West Sussex (it has long been known in similar marsh levels in East Sussex). At the Wild Brooks it lives in association with Anisus vorticulus; though not a new vice-comital record it is satisfying to report the continuing presence there of this rare planorbid, first noted at Amberley by A.E. Ellis in 1927 (Proceedings of the Malacological Society, London 18 (1928), p. 127) but not refound since 1966 and feared extinct in West Sussex.

Among introductions, the Mediterranean helicid *Cochlicella barbara*, first discovered at Torquay in 1975, has been found at a second British site, in South Wales. The Kenfig colony extends for about 400 m on grassy stabilised dunes along the sea (apparently to the local exclusion of the otherwise common *Cochlicella acuta*). Another introduced snail, the minute *Toltecia pusilla*, has been detected on walls and waste ground at several places in inner North London; the Highbury site is secondary scrub woodland with ground ivy on old railway land. *Toltecia* is now known from ten vice-counties, as far north as Cheshire and South Lancashire.

#### **INSTRUCTIONS TO AUTHORS**

Manuscripts should be sent to:

THE HON. EDITOR, DR P.G. OLIVER,
NATIONAL MUSEUMS & GALLERIES OF WALES, CATHAYS PARK, CARDIFF CF1 3NP.
GRAHAM.OLIVER@NMGW.AC.UK

Papers Two copies of text and illustrations should be submitted; one set of illustrations must be good quality originals. Authors should refer to *New Instructions to Authors* in Volume 36, No. 1 as a guide to format. Authors are reminded of the high cost of printing and therefore are expected to write concisely and to make maximum use of page size when designing artwork and tables.

COMMUNICATIONS These are intended to be short notes of an original nature which do not merit the treatment of a full paper. *Communications* do not normally contain any figures, tables or plates and should conform in style to that of recent issues of the *Journal*.

### Journal of Conchology

Vol. 36, No. 2, June 1998

#### Contents

	PAĞI
Papers	
BROWN D.S. & VERDCOURT B. A new genus and species of freshwater pulmonate (Planorbidae) from Kenya.	1
KILLEEN I.J. & LIGHT J.M. Observations on <i>Onoba semicostata</i> and <i>O. aculeus</i> around British and Northern French coasts.	<b>7</b>
OLIVER P.G., HOLMES A.M. & METTAM C. Mytilopsis leucophaeta, (Conrad, 1831) [Bivalvia: Dreissenoidea]. A species new to the British Fauna.	13
SEDDON M.B. & APARICO MT. Problematic taxa from Morocco - the status of "Helix argonautula" Webb & Berthelot, 1833, "Helix renati" Dautzenberg, 1894 and Xeroleuca antoinei Pallary, 1936.	19
TATTERSFIELD P. Three new species and a new subgenus of <i>Gulella</i> (Gastropoda: Streptaxidae) from Tanzania.	31
Wellens W. Redescription of <i>Coriocella nigra</i> de Blainville 1825 and <i>Chelyonotus tonganus</i> Quoy and Gaimard 1832 (Gastropoda: Prosobranchia: Lamellariidae).	43
COMMUNICATIONS  PIMENTA A.D. & ABSALÃO R.S. New names for four species of the genus	63
Turbonilla (Gastropoda, Heterobranchia, Pyramidellidae).  Von Proschwitz T. & Bennike O. Late Quaternary land snails from the southwestern Baltic Sea.	64
VERDCOURT B. A small contribution to the anatomy of <i>Trochonanina</i> (Urocyclidae, Trochonaninae).	65
Review	68
OBITUARY	70
Corrigenda	72
Non-marine Recorders Report	73

# Journal of Conchology

(Established 1874)

Vol. 36, Part 3, September 1998

Conchological Society of Great Britain and Ireland

### CONCHOLOGICAL SOCIETY OF GREAT BRITAIN AND IRELAND

Registered Charity No. 208205

Hon. Secretary Ms. J. Reynolds, 21c Loraine Road, Holloway, London N7 6EZ

Hon. Treasurer Ms. A.J. Trew, National Museums & Galleries of Wales, Cathays Park, Cardiff CF1 3NP

HON. MEMBERSHIP SECRETARY M.D. Weideli, 35 Bartlemy Road, Newbury, Berks. RG14 6LD

Hon. Editor Dr P.G. Oliver, National Museums & Galleries of Wales, Cathays Park, Cardiff CF1 3NP

Hon. Conservation Officer Dr M.J. Willing, 14 Goodwood Close, Midhurst, Sussex GU29 9JG

Hon. Marine Census Recorder Mrs J. Light, 88 Peperharow Road, Godalming, Guildford, Surrey GU7 2PN

Hon. Non-marine Census Recorder Dr M.P. Kerney, Department of Zoology, Natural History Museum, Cromwell Road, London SW7 5BD

Hon. Newsletter Editor Miss R.E. Hill, 447B Wokingham Road, Earley, Reading RG6 7EL

Member's subscription £23 per annum. Entrance fee £1.

FAMILY MEMBERSHIP £25 per annum.

Institutional membership £32 (UK rate); £37 (overseas\*) per annum.

STUDENT MEMBERSHIP £10 per annum.

\*Overseas members are reminded that all fees due to the Society are payable in pounds sterling.

Publications Members receive:

The Journal of Conchology (usually two numbers a year)

The Conchologists' Newsletter (quarterly)

For back-numbers of these publications and special numbers please apply to: Mr M.D. Weideli, 35 Bartlemy Road, Newbury, Berks. RG14 6LD.

MEETINGS There are six indoor meetings per year between October and May, usually held at the Natural History Museum. Field meetings, workshops and other events are held throughout the year at various locations.

© Conchological Society of Great Britain and Ireland Printed by Henry Ling, The Dorset Press, Dorchester DT1 1HD

### A PROPOSED NEOTYPE FOR HYDROBIA ACUTA (DRAPARNAUD, 1805)

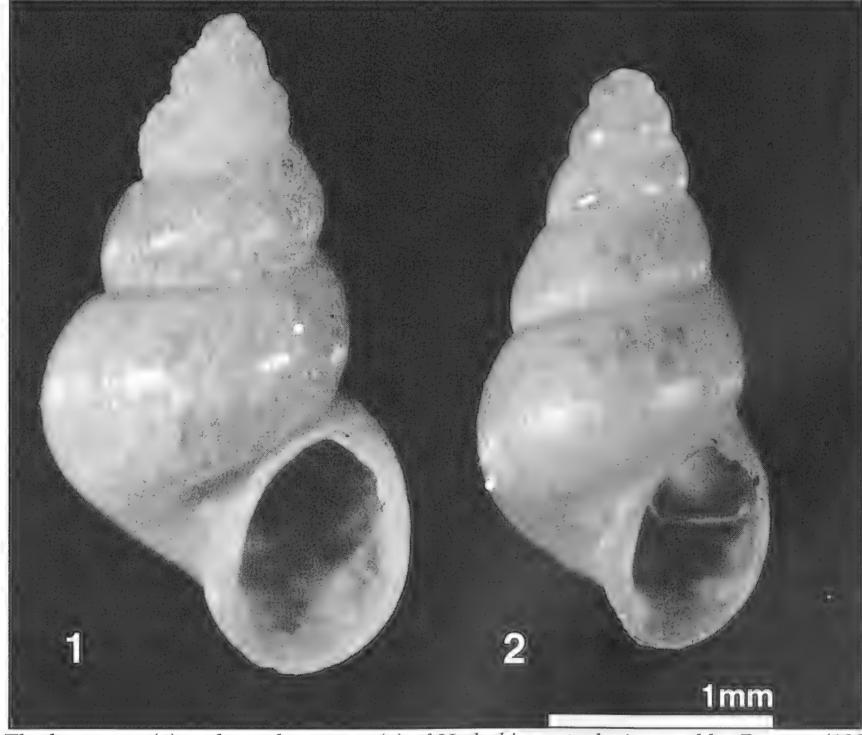
F. GIUSTI<sup>1</sup>, G. MANGANELLI<sup>1</sup> & M. BODON<sup>1</sup>

Abstract A lectotype for Hydrobia acuta (Draparnaud, 1805) was selected by Boeters (1984) from two syntypes found at the Museum National d'Histoire Naturelle in Paris. Although they are here demonstrated to belong to two different species, the type designation is valid and, if accepted, H. acuta becomes a junior synonym of H. ventrosa (Montagu, 1803). In order to conserve the current understanding of H. acuta, an application has been submitted to the ICZN to set aside the type designation of Boeters (1984) and to designate a neotype in line with the earlier and more widely accepted usage of the name.

Key words Hydrobia acuta, Neotype.

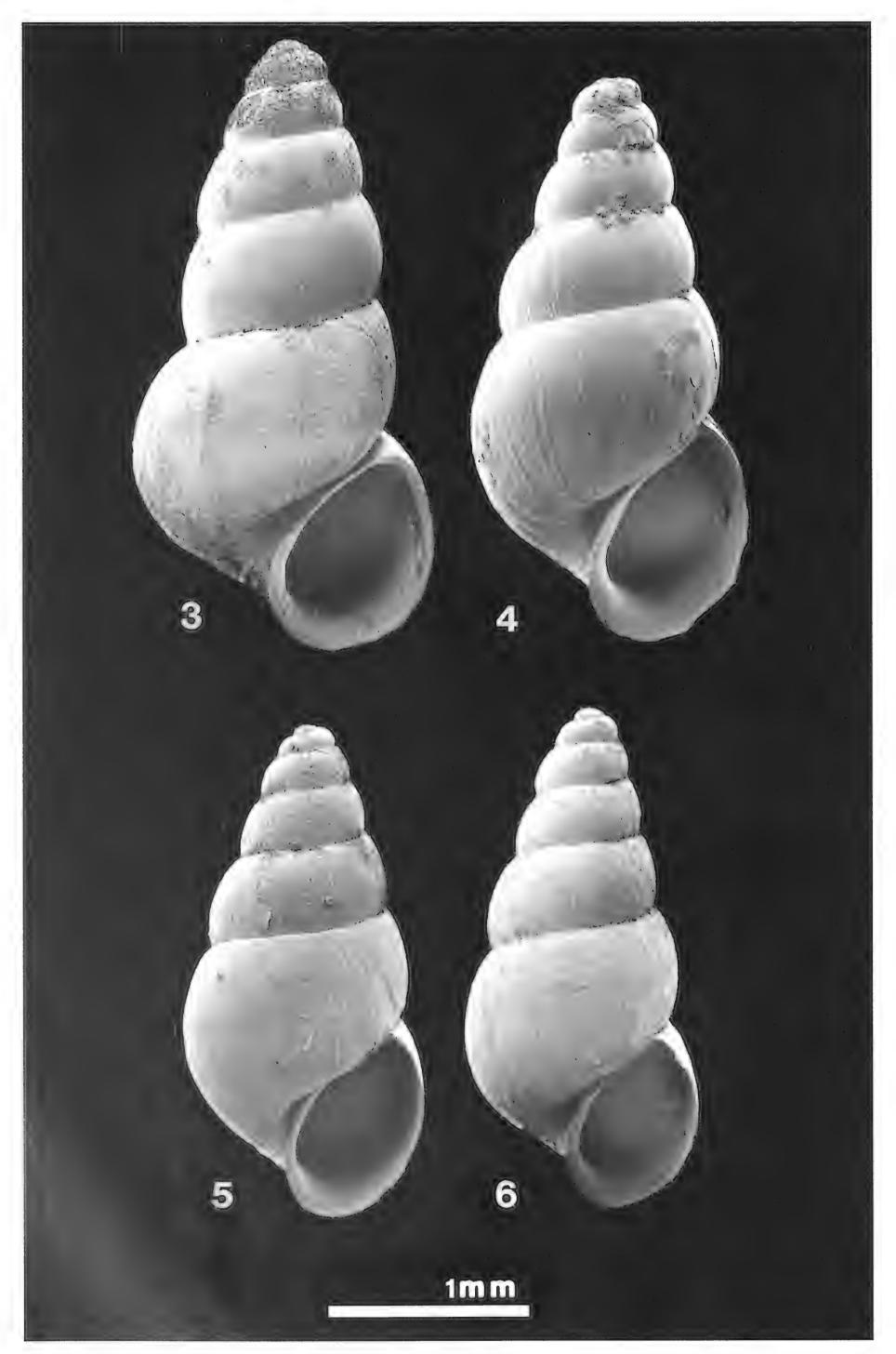
#### Introduction

Large populations of hydrobiids exist in brackish water environments of all Mediterranean coastal regions. These populations are usually mixed and often consist of two distinct morphospecies, one characterized by a shell which usually has rather flat whorls and superficial sutures, a body with tentacles having some longitudinal black

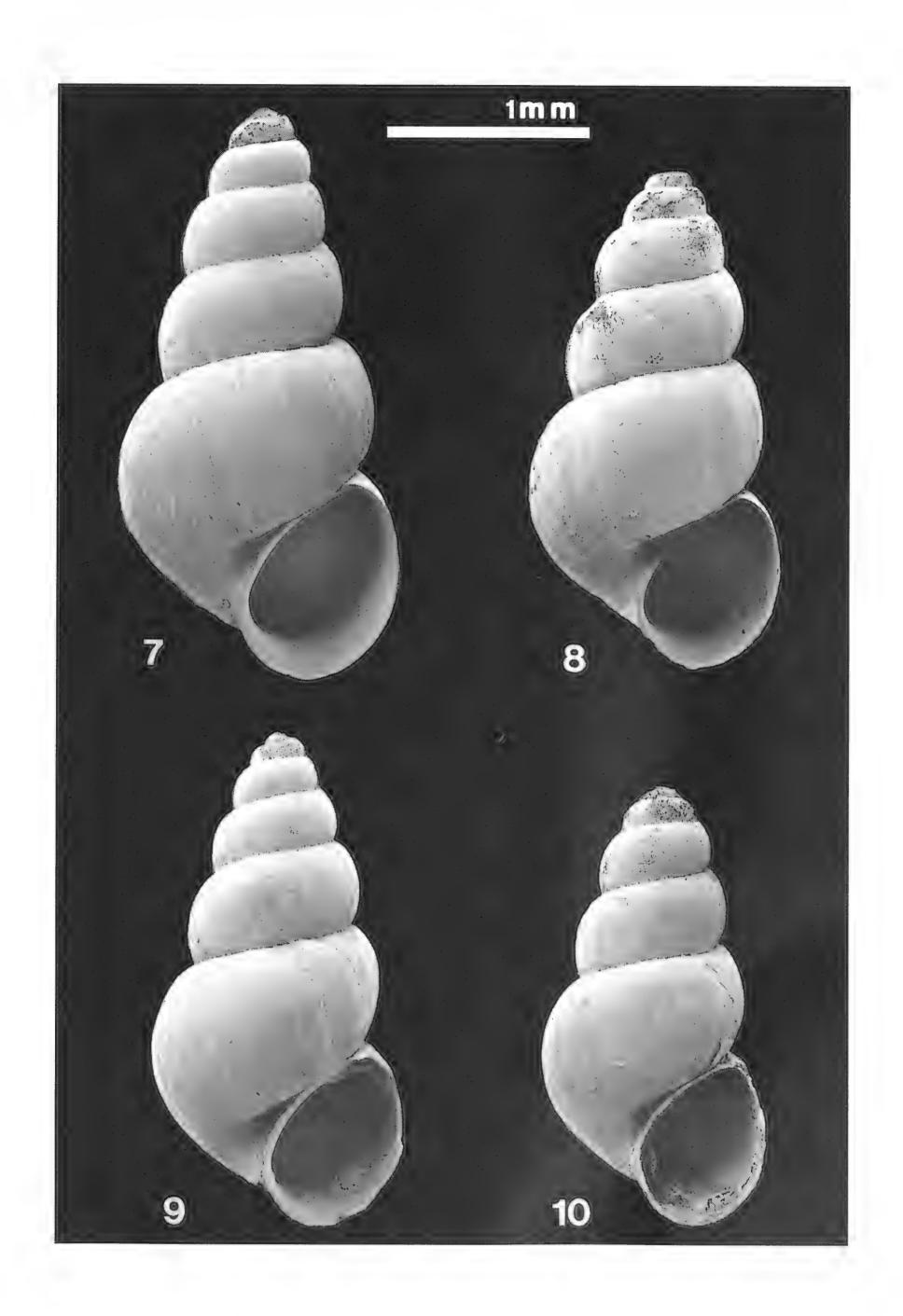


Figs1–2 The lectotype (1) and paralectotype (2) of *Hydrobia acuta* designated by Boeters (1984). The former is a specimen of *Hydrobia ventrosa* (Montagu, 1803) and the latter of *Hydrobia acuta* (Draparnaud, 1805) *sensu* Mars (1966) and Radoman (1977). Note that the shell of the lectotype has a different shape from that in the figure of Boeters (1984: Fig. 1). This is because the encrustations have been removed.

<sup>&</sup>lt;sup>1</sup> Dipartimento di Biologia Evolutiva, Universita di Siena, Via Mattioli 4,1-53100 Siena, Italy.



**Figs 3–10** Shells of *Hydrobia acuta* (Draparnaud, 1805) (**3–6**) and *Hydrobia ventrosa* (Montagu, 1803) (**7–10**) from the Étang du Prévost near Palavas-les-Flots, Montpellier (Hérault, France),



G. Manganelli leg. 7.5.1997. Proposed neotype of *Hydrobia acuta* (Fig. 5; Naturhistorisches Museum Wien, no. 90616). Al1 these shells are of anatomically determined specimens.

bands and a sub-apical, transverse black bar, and males with a penis having a variably wide fan-like lobe at the apex; the other is characterized by a shell which usually has rather convex whorls and deep sutures, a body with tentacles having a more or less visible, longitudinal, greyish band and males with an elongated penis having a pointed tip and a small lateral lobe, c.  $\frac{1}{2}$  of the distance from the base to the tip. Sometimes, a third less widespread morphospecies is found in the same habitats. It is characterized by a shell with convex whorls, the last contacting the preceding one over a comparatively long distance, a pale-grey body with a longitudinal whitish line along the tentacles, and males (never found in populations living in coastal sites in the Mediterranean) with a penis having 5–6 sucker-like structures. Females of the first two morphospecies have a black pigmented renal oviduct, whereas those of the latter have an unpigmented one (for detailed description, see Giusti & Pezzoli, 1984).

Although nominal taxa were introduced for these hydrobiids early in the zoological literature (e.g. *Cyclostoma acutum* Draparnaud, 1805, *Turbo ventrosus* Montagu, 1803, and *Helix stagnorum* Gmelin, 1791), much controversy arose over their identity because the

original descriptions did not enable sure identification.

The first author to produce sure determinations by coupling shell and body characters was Mars (1966) who referred to the first of the above morphospecies as *Hydrobia acuta* (Draparnaud, 1805), the second as *Hydrobia ventrosa* (Montagu, 1803) and the third as *Hydrobia macei* (Paladilhe, 1867). Radoman (1977) subsequently revised the first two species and gave the first conchological and anatomical description of the genus *Hydrobia* and its type species *H. acuta* for which he selected a restricted type locality ("Étang du Prévost, Palavas, franzosische Mittelmeerkuste"). Radoman also described the new genus *Ventrosia* for *H. stagnorum sensu* Radoman (i.e. *T. ventrosus*), and a series of similar species of *Hydrobia* and *Ventrosia* from the Mediterranean and the Black Sea coasts. As described by Radoman (1977), *H. acuta* is clearly that of Mars (1966), both conchologically and anatomically. Unfortunately neither Mars's (1966) or Radoman's (1977) revisions took the nomenclatural aspects (e.g. type designation) into account and this was a source of subsequent problems.

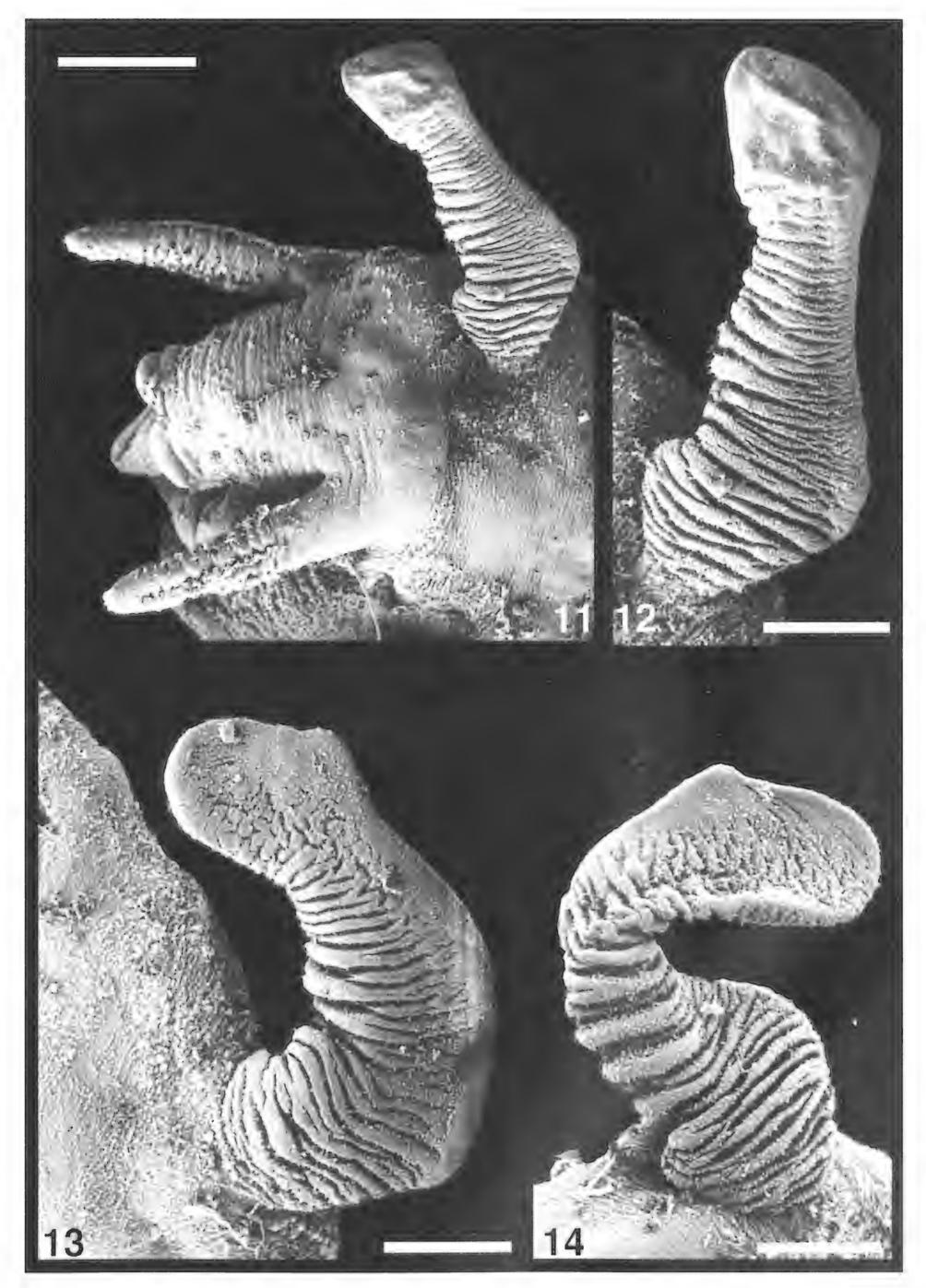
The status of two of the taxa, *Helix stagnorum* and *Turbo ventrosus*, was definitively clarified only recently by Bank *et al.* (1979) and Bank & Butot (1984). *H. stagnorum* is the first name available for the morphospecies (to which *H. macei sensu* Mars, 1966, seems to belong), the males of which have a penis with sucker-like structures, and *T. ventrosus* for the species the males of which have an elongated, pointed penis with a small lateral lobe c.  $\frac{1}{2}$  the way from the base to the tip. The status of *Cyclostoma acutum* Draparnaud,

1805, is still controversial.

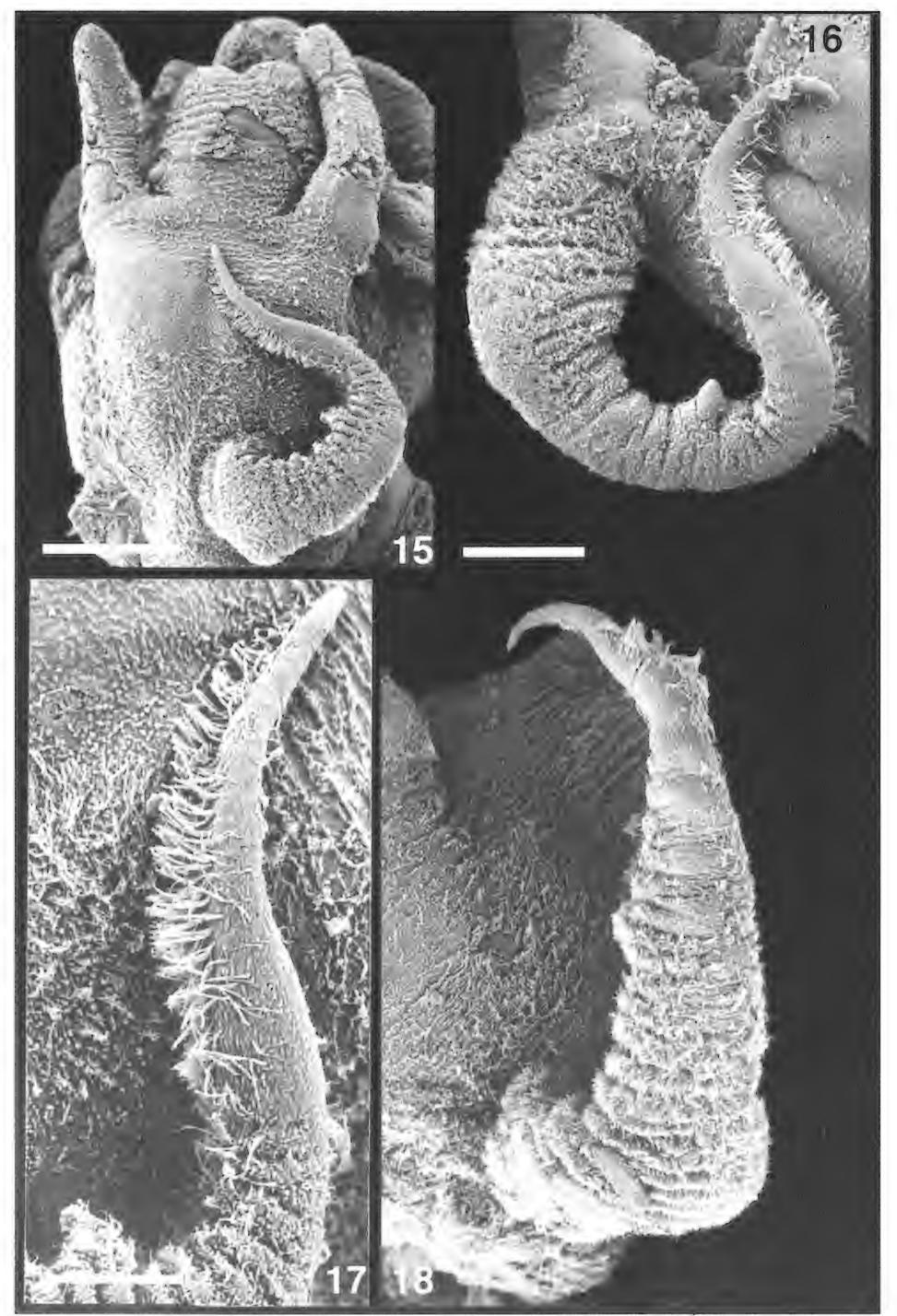
#### THE BOETERS (1984) Type Designation

Boeters (1984) selected a lectotype for *Cyclostoma acutum* Draparnaud, 1805, from two Putative syntypes found at the Museum National d'Histoire Naturelle in Paris (73 syntypes are at the Naturhistorisches Museum in Vienna; Giusti *et al.*, 1998). By comparing the lectotype with recent material collected in the Étang du Prévost, he then selected that of the two hydrobiid species with males having an elongated, pointed penis with a small lateral lobe c.  $\frac{1}{2}$  of the way from the base to the apex as C. *acutum*. The other species, the males of which have a penis with a large fan-like lobe at the apex, i.e. H. *acuta sensu* Mars (1966) and Radoman (1977), is referred to by Boeters (1984) as *Hydrobia* sp. In so doing Boeters interpreted H. *acuta* quite differently from Mars (1966) and Radoman (1977).

Giusti & Pezzoli (1984: 124, footnote 13) immediately contested Boeter's interpretation, as the characters of the shells designated as lectotype and paralectotype (Boeters,



**Figs11–14** Body of males and penis of *Hydrobia acuta* (Draparnaud, 1805). Étang du Prévost near Palavas-les-Flots, Montpellier (Hérault, France), G. Manganelli leg. 7.5.1997. Anterior portion of body and penis of the proposed neotype (11–12; Naturhistorisches Museum Wien, no. 90616). Scale bars: 200  $\mu$ m (11) and 180  $\mu$ m (12–14).



Figs 15–18 Body of males and penis of *Hydrobia ventrosa* (Montagu, 1803). Étang du Prévost near Palavas-les-Flots, Montpellier (Hérault, France), G. Manganelli leg. 7.5.1997. Scale bars: 200  $\mu$ m (15), 180  $\mu$ m (16,18) and 50  $\mu$ m (17).

1984: Pl. 1, Figs 1–2) were similar to those of shells of the *Hydrobia* species characterized by penis with a large fan-like lobe at the apex (i.e. *H. acuta sensu* Mars and Radoman). Giusti & Pezzoli (1984) continue to identify *H. acuta* as intended by Mars and Radoman, as do Cesari (1988), Sabelli *et al.* (1990–92), Haase (1993), Bodon *et al.* (1995), Giusti *et al.* (1995), Cachia *et al.* (1996), Giannuzzi-Savelli *et al.* (1997) and Hoeksema (1998).

Fig. 1 of Boeters (1984) shows the lectotype not only as a peculiar shell with an abnormally developed, slightly despiralized last whorl and wide umbilicus (both *H. acuta* and *H. ventrosa* from the Étang du Prévost sometimes have similar shells; Figs 3, 7), but also with flat first whorls, thus suggesting that it might belong to *H. acuta sensu* Mars (1966) and *sensu* Radoman (1977). Direct study demonstrated that, the upper part of the spire was actually encrusted and gave an incorrect idea of the convexity of the whorls and the depth of the sutures. After the encrustations had been removed the convexity of the whorls and depth of the sutures suggested that the lectotype was *H. ventrosa*. The paralectotype (Fig. 2) can be clearly identified as *H. acuta sensu* Mars (1966) and *sensu* Radoman (1977) by virtue of its flat whorls and superficial sutures. The additional type material at the Naturhistorisches Museum in Wien also includes both species.

#### A NEOTYPE FOR HYDROBIA ACUTA (DRAPARNAUD, 1805)

Although Boeters (1984) did not realize that the lectotype and the paralectotype belonged to two different species, his type designation is valid and, if accepted, *H. acuta* becomes a junior synonym of *H. ventrosa* and a new name is required for *H. acuta sensu* Mars, 1966, and Radoman, 1977.

In order to settle this case, an application has been submitted to the ICZN to conserve the current understanding of *H. acuta* by setting aside the type designation of Boeters (1984) and by designating a neotype in line with the earlier and more widely accepted

usage of the name (Giusti et al., 1998).

The proposed neotype was collected in the Étang du Prévost near Palavas-les-Flots (Hérault, France) (the type locality as restricted by Radoman, 1977) and is deposited in the Naturhistorisches Museum Wien (catalogue no. 90616). It is a male specimen. The shell and the anterior portion of the body with penis are shown in Figs 5, 11–12.

#### **A**CKNOWLEDGEMENTS

We thank Leonardo Gamberucci, Antonella Daviddi and Luigi Federico Falso for technical assistance, Leonardo Favilli for preparing Figs 1–2, and Thomas Wilke for his valuable comments. Special thanks to G. Cappelli, L. Manganelli, C. Mellone, A. Pinsuti, G. Pistolozzi and P. Ravaglioli for their cooperation during the field work.

This research was supported by CNR, MURST 40% and MURST 60% grants.

#### REFERENCES

BANK R.A. & BUTOT L.J.M. 1984 Some more data on *Hydrobia ventrosa* (Montagu, 1803) and "*Hydrobia*" stagnorum (Gmelin, 1791) with remarks on the genus *Semisalsa* Radoman, 1974 (Gastropoda, Prosobranchia, Hydrobioidea) *Malakologische Abhandlungen* (*Dresden*) **10**: 5–15.

BANK R.A. & BUTOT L.J.M. & GITTENBERGER E. 1979 On the identity of *Helix stagnorum* Gmelin, 1791 and *Turbo ventrosus* Montagu, 1803 (Prosobranchia, Hydrobiidae) *Basteria* 43: 51–60.

- Bodon M., Manganelli G., Favilli L. & Giusti F. 1995 Prosobranchia Archaeogastropoda Neritimorpha (generi 013–014); Prosobranchia Caenogastropoda Architaenioglossa (generi 060–065); Prosobranchia Caenogastropoda Neotaenioglossa p.p. (generi 070–071, 077, 095–126); Heterobranchia Heterostropha p.p. (genere 294). *In* Minelli A., Ruffo S. & La Posta S. (eds) *Checklist delle specie della fauna d'Italia* 14 (Gastropoda Prosobranchia, Heterobranchia): 60 pp.
- BOETERS H.D. 1984 Zur Identitat des Hydrobia-Typus (Prosobranchia: Hydroblidae) Heldia 1: 3-5.
- CACHIA C., MIFSUD C. & SAMMUT P.M. 1996 The marine Mollusca of the Maltese Islands (Part Two: Neotaenioglossata) Backhuys Publishers, Leiden 228 pp.
- CESARI P. 1988 La malacofauna della Laguna Veneta. 1. Gasteropodi terrestri, dulciacquicoli e salmastri dei litorali di Pellestrina, Lido e Cavallino (Mollusca Prosobranchia e Pulmonata) Bollettino del Museo Civico di Storia Naturale di Venezia 38: 7–42.
- GIANNUZI-SAVELLI R., PUSATERI F., PALMIERI A. & EBREO C. 1997 Atlante delle conchiglie marine del Mediterraneo. Vol. 2 (Caenogastropoda parse 1: Discopoda Heteropoda) Edizioni La Conchiglia, Roma 258 pp.
- GIUSTI F., MANGANELLI G. & BODON M. 1998 *Hydrobia* Hartmann, 1821 and *Cyclostoma acutum* Draparnaud, 1805 (currently *Hydrobia acuta*; Mollusca, Gastropoda): proposed conservation by replacement of the lectotype of *C. acutum* with a neotype; *Ventrosia* Radoman, 1977: proposed designation of *Turbo ventrosus* Montagu, 1803 as the type species; and *Hydrobiina* Mulsant, 1844 (Insecta, Coleoptera): proposed emendation of spelling to *Hydrobiusina*, so removing the homonymy with Hydrobiidae Troschel, 1857 (Mollusca). *Bulletin of Zoological Nomenclature* 55 (3): 139–145.
- GIUSTI F., MANGANELLI G. & SCHEMBRI P.J. 1995 The non-marine molluscs of the Maltese Islands. Monografie Museo Renionale di Scienze Naturali (Torino) 15: 607 pp.
- GIUSTI F. & PEZZOLI E. 1984 Notulae Malacologicae, XXIX. Gli Hydrobiidae salmastri delle acque costiere italiane: primi cenni sulla sistematica dei gruppo e sui caratteri distintivi delle singole morfospecie *Lavori della Societa Italiana di Malacologia (Atti del Simposio di Bologna 24–26.9.1982)* **21**: 117–148.
- Haase M. 1993 The genetic differentiation in three species of the genus *Hydrobia* and systematic implications (Caenogastropoda, Hydroblidae) *Malacologia* **35**: 389–398.
- HOEKSEMA D.F. 1998 Note on the occurrence of *Hydrobia acuta* (Draparnaud, 1805) (Gastropoda, Prosobranchia: Hydrobiidae) in western Europe, with special reference to a record from S. Brittany, France *Basteria* **61**: 101–113.
- Mars P. 1966 Recherches sur quelques étangs du littoral Méditerranéen français et sur leur faune malacologique *Vie Milieu* **20**: 1–359.
- RADOMAN P. 1977 Hydroblidae auf der Balkanhalbinsel und in Kleinasien *Archiv für Molluskenkunde* **107**: 203–223.
- RADOMAN P. 1983 Hydrobioidea a superfamily of Prosobranchia. 1 Systematics Serbian Academy of Sciences and Arts Mongraphs Department of Sciences 57: 256 pp.
- Sabelli B., Giannuzzi-Savelli R. & Bedulli D. 1990–92 Catalogo annotato dei molluschi marini del Mediterraneo 1: 1–348 (1990); 2: 349–498 (1992); 3: 499–781 (1992) Edizioni Libreria Naturalistica Bolognese, Bologna.

### EGG LAYING ACTIVITY OF THE SLUG ARION LUSITANICUS MABILLE IN SWITZERLAND

T. Briner<sup>1</sup> and T. Frank<sup>1</sup> \*

Abstract 1. Arion lusitanicus Mabille was found to lay more than 200 eggs per clutch with an egg volume between 11 and 34 mm³.

- 2. The weight of adult individuals of A. lusitanicus varied between 3 and 27 g.
- 3. The body weight of the slugs correlated positively with egg volume. However, there was no correlation found between body weight and the number of eggs per clutch, or between egg volume and the number of eggs per clutch.
- 4. Clutch size decreased over the period of the investigation.
- 5. Slug density was probably responsible for the differences observed in the reproduction parameters, measured at three different locations.

Key words Arion lusitanicus, Egg laying, Reproduction parameters, Bern (Switzerland).

#### Introduction

In spite of its size and its increasing importance as an agricultural pest, little is known about the biology of Arion lusitanicus. Most of the basic research on slug biology was done more than thirty years ago (Dainton, 1943; Barnes and Weil, 1945; Frömming, 1954; Quick, 1960; South, 1965), at a time when A. lusitanicus was not known in Central Europe. In Switzerland, A. lusitanicus was discovered for the first time in 1955 (Schmid, 1970), in Germany in 1969 (Schmid, 1970) and in Austria in 1972 (Reischütz and Stojaspal, 1972). Its origin is still not clarified; Schmid (1970) suggested it may be introduced into Central Europe from Southern Europe, but it may also have originated in the Alpine region (Davies, pers. comm.). Presently this species spreads out agressively and displaces the indigenous and closely related species Arion rufus (Linnaeus) (Reischütz, 1986; Högger, 1996; Proschwitz, 1996). Together with Deroceras reticulatum (Müller), A. lusitanicus is one of the most important agricultural slug pests in Central Europe (Reischütz, 1986). Especially high damage caused by A. lusitanicus was recorded in oilseed rape adjacent to wildflower strips (Frank, 1998). To enable an effective control of this slug pest further information on the biology of A. lusitanicus is necessary. Since almost nothing is known about reproduction rates of A. lusitanicus, body size, clutch size and egg volume of this species are investigated in this paper. The body size (expressed as body weight) was assumed to influence the reproduction parameters of clutch size and egg volume.

It was also analysed whether the time of the year when eggs are laid influences the number of eggs per clutch or the egg volume, as it is unknown for the landsnail *Cepaea nemoralis* (L.) (Wolda & Kreulen 1973; Carter & Ashdown 1984).

#### MATERIAL & METHODS

At the end of August 1996, when slugs kept in the laboratory began to lay eggs, specimens of adult *A. lusitanicus* were collected from three locations near Bern (Table 1).

<sup>&</sup>lt;sup>1</sup> Zoological Institute, University of Bern, CH-3012 Bern, Switzerland.

<sup>\*</sup> Correspondence author

TABLE 1 Description of the locations where the slugs were collected

Specifics of the studied locations	<u>Location 1</u> Hindelbank wildflower strip & field	Location 2 Hindelbank wildflower strip	Location 3 Belp wildflower strip & field
Inclination	flat	inclined	flat
Crop plant	potato	maize	sugar beet
Sowing date	11.4.1996	6.5.1996	17.4.1996
Germination date	20.4.1996	25.5.1996	26.4.1996
Preceding crop	winter wheat	potato	rape
Soil texture	poor sandy loam	sandy loam	loam
pН	6.9	5.6	8
Organic matter	>2%	<2%	3–4%

Adult slugs were sampled from three wildflower strips and the crop fields bordering on these strips (there were no slugs found in the crop area at location 2).

All slugs were sampled in moist weather and were weighed as soon as they were brought into the laboratory. Pairs of individuals with similar body weights were put together into a box (16 x 11 x 6 cm). Slugs were kept in pairs so that they had an opportunity to mate, if they had not already been fertilized in the field. The slugs were kept under constant conditions in an environmental chamber with a temperature cycle of 20°C for 16h and 15°C for 8h. The regimen was linked to a photoperiod of 16L:8D, and slugs were fed with dandelion (*Taraxacum officinale*). Every day the boxes were inspected for eggs. In egg clutches found, the number of eggs was counted and the length and width of ten randomly chosen eggs per clutch were measured in order to calculate the mean egg volume. For egg clutches consisting of more than 130 eggs, length and width were measured for fifteen randomly chosen eggs; for those comprising more than 200 eggs, twenty randomly chosen eggs were measured. The volume (V) was calculated with the formula:

#### $V=1/6 \times \pi \times w^2 \times L$

where w is the egg width and L is the egg length. For the evaluation, only data from egg clutches with more than ten eggs were used because in very small clutches no young hatch (Godan, 1979).

Observation of a slug pair was terminated when any one of the following conditions was fulfilled:

- a) When both slugs died;
- b) One month after the last egg laying of the pair;
- c) Two months after the first eggs were laid by one pair from the same location;
- d) Three months after the beginning of the observation on the pair.

These different ways of observation were necessary because several slugs began to lay eggs only some weeks after having been brought into the laboratory.

Since no significant differences between the data from the field sites and those from the adjacent wildflower strips were found (Mann-Whitney U-test; 2-tailed; p>0.05), data from each location were pooled to one data set.

The number of egg clutches investigated was 9 for location 1, 7 for location 2, and 47 for location 3.

For the calculations of correlation, data from all three locations were pooled.

Because slugs were kept in pairs, the egg clutches could not be assigned to a single slug. Therefore the body weights used in the correlations were mean body weights of the slugs in each pair.

#### RESULTS

The maximum number of eggs per clutch was 225. The number of clutches laid by one pair was between zero and four. The number of eggs per clutch at location 3 was significantly higher than at location 2 (p=0.005). However, there was no significant difference in number of eggs per clutch between location 1 and location 2 (p=0.152), or between location 1 and location 3 (p=0.25; Fig. 1).

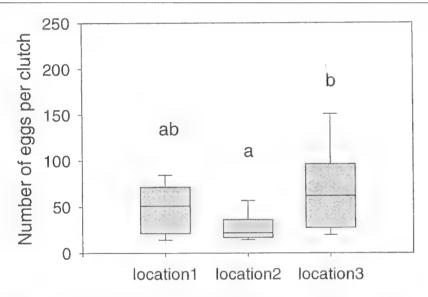
Egg volume varied between 11 and 34 mm<sup>3</sup>, but there was no significant difference

between the three locations (Fig. 2).

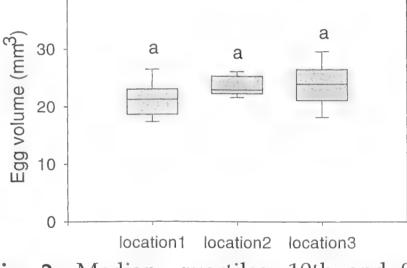
Body weight of the slugs varied between 2.9 and 26.8 g. The weight of slugs between location 1 and 2 (p=0.001) as well as between location 1 and 3 (p<0.001) was significantly different. However, there was no significant difference between location 2 and 3 (p=0.494; Fig. 3).

The assumption, that the body weight of the slugs influences the clutch size or the egg volume was not completely confirmed. Slug body weight correlated positively and

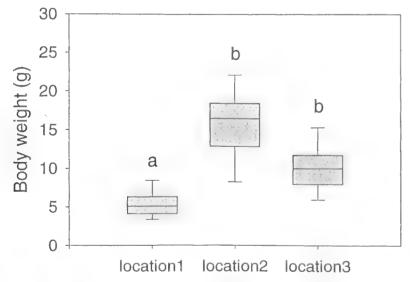
40



**Fig. 1** Median, quartiles, 10th and 90th percentiles of the number of eggs per clutch at the three tested locations. Different letters mean significant differences between the locations (Mann-Whitney U-test; 2-tailed; p<0.05).



**Fig. 2** Median, quartiles, 10th and 90th percentiles of the egg volume at the three tested locations. Different letters mean significant differences between the locations (Mann-Whitney U-test; 2-tailed; p<0.05).



**Fig. 3** Median, quartiles, 10th and 90th percentiles of the body weight at the three tested locations. Different letters mean significant differences between the locations (Mann-Whitney U-test; 2-tailed; p<0.05).

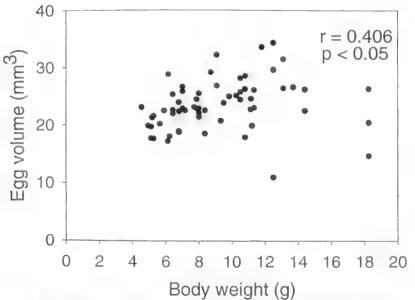


Fig. 4 Relationship between body weight and the egg volume. Spearman's index.

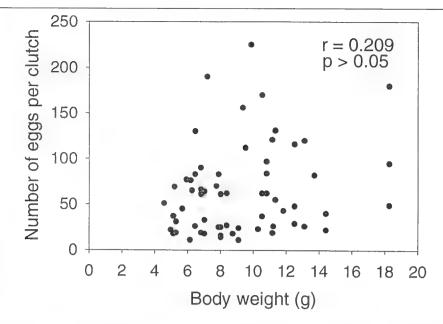


Fig. 5 Relationship between body weight and number of eggs per clutch. Spearman's index.

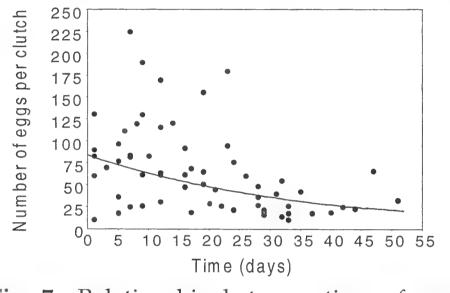


Fig. 7 Relationship between time of egg laying and number of eggs per clutch with the exponential function. Spearman's index.

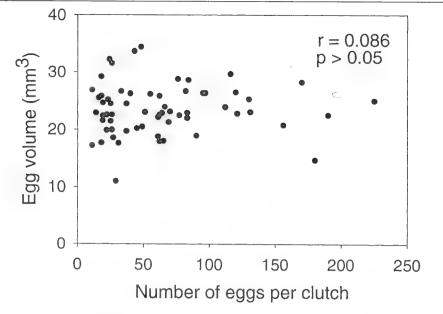
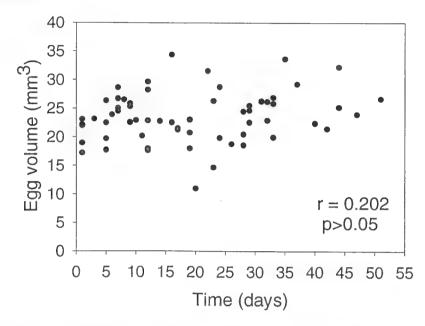


Fig. 6 Relationship between number of eggs per clutch and egg volume. Spearman's index.



**Fig. 8** Relationship between time of egg laying and egg volume. Spearman's index.

significantly (p=0.01) with the egg volume (Fig. 4). There was no significant correlation between body weight and number of eggs per clutch (p=0.1; Fig. 5) or between number of eggs per clutch and egg volume (p=0.51; Fig. 6).

When clutch size was plotted against time, a strong negative nonlinear correlation (p<0.001) was observed (Fig. 7). It could be best explained with the exponential function:

$$N=83.74 \times exp(-0.0278 \times t)$$

where N is the number of eggs per clutch and t is the time. The egg volume was more or less constant during the period of observation (p=0.11; Fig. 8).

#### **DISCUSSION**

There was a wide range of body weights observed in the present study. The variable body size and body weight respectively seems to be typical of *A. lusitanicus*, as Davies (1987) found adult individuals ranged from 4 to 15 cm in length. It was expected that the body weight of the slugs would be correlated with the egg volume and the number of eggs per clutch, because this has already been shown for some insects and snails. Berrigan (1991) found a correlation between body size and egg number (e.g. in Diptera), and between body size and egg size (e.g. in Diptera, Hymenoptera, Coleoptera). Correlation between body size and egg number as well as between body size and egg

13

size have been reported in *Cepaea nemoralis* (Wolda & Kreulen, 1973; Carter & Ashdown, 1984). This assumption was only partially confirmed in our study; despite a great spread of body weights there was no correlation found between the body weight and the

number of eggs per clutch.

Consequently it cannot be predicted whether heavier slugs lay more eggs per clutch than slugs that are up to four or five times lighter. This is rather surprising but it corresponds well with the data for body weight and number of eggs per clutch recorded at the three different locations. Body weights at locations 1 and 2 differed significantly; however there was no significant difference in numbers of eggs per clutch between these locations.

The significant differences between the three locations may have different causes. The different crop plants or the different soil properties at the three locations probably influenced the development of the slugs. The most important of the soil properties is soil moisture (South, 1965). pH range, and availability of soluble carbonates in the soil do not influence slugs greatly (Stephenson, 1968; Reischütz, 1986).

The time of hatching may be responsible for differences in body size. The bigger slugs may have hatched in the autumn of the previous year and therefore matured earlier than those that hatched in the spring. The possibility, that the smaller individuals were only subadult can be ruled out, because they did not continue to grow but did lay eggs.

A more important reason for differences in slug development appeared to be the density of slugs at each location. In some molluscs (e.g. Cepaea nemoralis, Fossaria cubensis (Pfeiffer), Helix aspersa Müller) a high population density has been shown to restrict growth and reproduction in the laboratory (Berrie and Visser, 1963; Herzberg, 1965; Levy, Tunis & Isseroff, 1972; Cameron and Carter, 1979; Carter & Ashdown, 1984). The assessment of density of A. lusitanicus performed in the three studied locations suggested that slug density influenced the growth and reproductive parameters measured. At location 1, where the density of slugs was approximately three- to tentimes higher than at location 2 and 3 (personal observation, supported by data from searching defined areas in the field for slugs), the individuals were clearly smaller than at the other locations. If a high density of slugs can inhibit growth and reproduction in the field, further research on this topic would be of relevance to the control of slug pests.

Egg volume was rather constant at the different locations throughout the year. Also it did not appear to be influenced by the number of eggs per clutch. Rollo (1983) found similar results in the closely related species *Arion ater* (L.). Davies (1987) estimated the egg size of *A. lusitanicus* in Britain at about 4 mm in diameter, which corresponds very

well with the eggs found in Switzerland.

In contrast, clutch size was more variable and decreased over the period of the investigation. A seasonal decrease in clutch size has already been observed for *Cepaea nemoralis* (Wolda & Kreulen, 1973; Carter & Ashdown, 1984). A similar phenomenon is also known to occur in other animals such as birds, lizards and insects. However, the reason for this seasonal decrease has not yet been investigated. Wolda & Kreulen (1973) suggested that food quality or the digestible energy content could lead to a seasonal decrease in the size of egg clutches, because when plants mature during the growing season the proportion of fibre to protein and soluble carbohydrates in their tissues increases. They also suggested that the effect of decreasing egg clutch size occurs only in the field, not in the laboratory. If the change in food quality plays an important role in decreasing the clutch size, the decline observed in the present study does not contradict the suggestion of Wolda & Kreulen (1973), because the slugs were fed continuously with plant material from the field, which was of course also liable to seasonal change in quality.

Maybe there are further factors involved in the regulation of the reproduction. It is possible, for example, that there are some circannual rhythms controlled by photope-

riod, which play a role in the regulation of the egg laying behaviour of molluscs (Sokolove and McCrone, 1978; Bailey, 1981).

#### **ACKNOWLEDGEMENTS**

The authors are grateful to J. Heller and P. Mordan for helpful comments on an earlier text version.

#### REFERENCES

- Bailey S.E.R. 1981 Circannual and circadian rhythms in the snail *Helix aspersa* (Müller) and the photoperiodic control of annual activity and reproduction *Journal of Comparative Physiology* **142**: 89–94.
- Barnes H.F. and Weil J.W. 1945 Slugs in garden: their numbers, activities and distribution, Part 2 *Journal of Animal Ecology* **14**: 71–105.
- Berrie A.D. and Visser S.A. 1963 Investigations of a growth-inhibiting substance affecting a natural population of freshwater snails *Physiological Zoology*. *Chicago* **36**: 167–173.
- Berrigan D. 1991 The allometry of egg size and number in insects Oikos 60: 313-321.
- CAMERON R.A.D. AND CARTER M.A. 1979 Intra- and interspecific effects of population density on growth and activity in some helicid land snails (Gastropoda: Pulmonata) *Journal of Animal Ecology* **48**: 237–246.
- CARTER M.A. AND ASHDOWN M. 1984 Experimental studies on the effects of density, size, shell colour and banding phenotypes on the fecundity of *Cepaea nemoralis Malacologia* **25** (2): 291–302.
- DAVIES S.M. 1987 *Arion flagellus* Collinge and *A. lusitanicus* Mabille in the British isles: A morphological, biological and taxonomic investigation *Journal of Conchology* **32**: 339–354.
- Dainton B.H. 1943 Effect of air currents, light, humidity and temperature on slugs *Nature*. *London* **151**: 25.
- Frank T. 1998 Slug damage and numbers of the lug pests, *Arion lusitanicus* and *Deroceras reticulatum*, in oilseed rape grown beside sown wildflower strips *Agriculture*, *Ecosystems and Environment* **67**: 67–78.
- FRÖMMING E. 1954 Biologie der mitteleuropäischen Landgastropoden Duncker und Humbolt, Berlin.
- GODAN D. 1979 Schadschnecken und ihre Bekämpfung Ulmer, Stuttgart.
- HERZBERG F. 1965 Crowding as a factor in growth and reproduction of *Helix aspersa American Zoologist* 5: 234.
- HÖGGER CH. 1996 Schneckenregulierung: keine einmalige Angelegenheit Die Grüne 48: 22–25.
- Levy M.G., Tunis M. and Issroff H. 1972 Population control in snails by natural inhibitors *Nature*. *London* **241**: 65–66.
- Proschwitz T. von 1996 *Arion lusitanicus* Mabille and *A. rufus* (L.) in Sweden, a review of the occurrence, spread and naturalization *Göteborgs Naturhistoriska Museum*, *Arstryck* 1996 27–45.
- Quick H.F. 1960 British slugs (Pulmonata: Testacellidae, Arionidae, Limacidae) Bulletin of the British Museum of Natural History (Zoology) 6: 105–226.
- Reischütz P.L. 1986 Die Verbreitung der Nacktschnecken Oesterreichs (Arionidae, Milacidae, Limacidae, Agrolimacidae, Bottgerillidae) Supplement 2 des Catalogus Faunae Austriae 67–159.
- Reischütz P.L. and Stojaspal F.J. 1972 Bemerkenswerte Mollusken aus Ostösterreich Mitteilungen der Zoologischen Gesellschaft Braunau 1: 339–344.
- ROLLO D.C. 1983 Consequences of competition on the reproduction and mortality of three species of terrestrial slugs *Researches on Population Ecology* **25**: 20–43.
- Schmid G. 1970 Arion lusitanicus in Deutschland Archiv für Molluskenkunde 100: 95–102.
- SOKOLOVE P.G. AND McCrone E.J. 1978 Reproductive maturation in the slug Limax maximus and

- effects of artificial photoperiod Journal of Comparative Physiology 125: 317–325.
- SOUTH A. 1965 Biology and ecology of *Agriolimax reticulatus* (Müll.) and other slugs: spatial distribution *Journal of Animal Ecology* **34**: 403–417.
- Stephenson J.W. 1968 A review of the biology and ecology of slugs of agricultural importance *Proceedings of the Malacological Society. London* **38**: 169–178.
- Wolda H. and Kreulen D.A. 1973 Ecology of some experimental populations of the landsnail *Cepaea nemoralis* (L.). II. Production and survival of eggs and juveniles *Netherlands Journal of Zoology* 23: 168–188.

### A NEW GENUS OF ZONITOIDEA PREVIOUSLY REFERRED TO KALIELLA

J. GERLACH<sup>1</sup>

Abstract The Seychelles species previously known as Kaliella subturritula (Nevill, 1871) is referred to a new genus, Nesokaliella, and a second species recognised and described as N. minuta.

Key words Nesokaliella, Seychelles, Mahé, Silhouette.

#### Introduction

The Asian Helicarionid genus *Kaliella* was first recorded in the westem Indian Ocean in 1898 when the generic name was applied to the Seychelles species *Helix* (*Conulus*) subturritula G. & H. Nevill, 1871 (Martens, 1898). Subsequently two undescribed species from Aldabra and Coetivy were referred to the genus (Barnacle, 1962).

Close examination of available material reveals a number of differences between 'Helix' subturritula and other Kaliella species including the absence of mantle lobes, a caudal horn and the lack of penial diverticulae. The type species of Kaliella Blanford, 1863, K. barrakporensis Pfr., 1852, differs from 'Helix' subturritula in the possession of a caudal horn above the caudal mucous pore, a pear-shaped diverticulum at the junction of the vas deferens and penis and 7 lateral teeth. These differences confirms that 'H.' subturritula is not a species of Kaliella. The absence of mantle lobes and a caudal horn, the presence of broad marginal teeth and the absence of penial diverticulae suggest that the Seychelles species may not belong in this family. The divisions between the Zonitoidea (s.l.) families are not clear and many of the more obvious characters may not be found in all members of a family. Caudal horns and mantle lobes may be absent or reduced in some species of Zonitidae, Helicarionidae, Euconulidae and Urocyclidae (Baker, 1941; Pilsbry, 1946; Goethem, 1977), penial diverticulae may not be present in some Zonitidae and Euconulidae (Baker, 1941; Pilsbry, 1946) and the broad 3-4 cusped marginal teeth of the Seychelles 'Kaliella' are found in some Euconulidae and Urocyclidae (Pilsbry, 1946; Goethem, 1977). Of the other anatomical data available, ganglia arrangements suggest clearer divisions between some of these families, although only a relatively small number of genera have been examined. The Seychelles 'Kaliella' has approximately equidistant pleural, pedal and cerebral ganglia and the visceral ganglion contacts the right parietal ganglion, although remaining separate. Within the Zonitoidea this arrangement is found only in the Euconulidae (Tillier, 1989). It is therefore reasonable to assume that the Seychelles species previously referred to Kaliella belong to an undescribed euconulid genus.

During this re-examination of the generic status of the Seychelles 'Kaliella' two distinct species within 'Kaliella' subturritula were noted. The two Seychelles species are described below and are placed in a new genus.

#### ABBREVIATIONS

BM(NH)	British Museum (Natural History)
NPTS	Nature Protection Trust of Seychelles
UMZ	University Museum of Zoology, Cambridge

<sup>&</sup>lt;sup>1</sup> 53 River Lane, Cambridge CB5 8HP, UK.

#### Systematic Description

Genus *Nesokaliella* n. gen. Type species *Helix* (*Conulus*) *subturritula* G. & H. Nevill, 1871

Description Shell conical with 5–6 straight-sided whorls. Protoconch 2 smooth whorls. Apex blunt. Sculpture of fine radial growth lines; microscopic radial ridges or 4 spiral striae may be present. Sculpture present on underside. Umbilicus open, small.

Body without a caudal horn; tail distinctly flattened. Jaw plate simple, lateral margins angled inwards. Central radula tooth symmetrical; 9 laterals; 27–39 broad marginals with 3–4 cusps. Spermoviduct elongate, simple or inflated basally. Spermatheca duct long and narrow, arising from genital atrium. Spermatheca oval.

Penis elongate, inflated terminally. No epiphallus, no penial diverticulae or ornament.

Penial retractor muscle terminal.

Derivation of name A composite of the Greek **nesos** (island) and the generic name Kaliella.

Distribution Seychelles endemic, recorded from forests on Mahé, Silhouette and Felicite

#### Nesokaliella subturritula (G. & H. Nevill, 1871)

Fig. 1

Helix (Conulus), n. sp.? Nevill 1870: 63

Helix (Conulus) sub-turritula G. & H. Nevill, 1871: 7

Nanina (Microcystis) subturritula Nevill 1878: 1

Kaliella subturritula Martens 1898: 16

Kaliella subturritula Sykes 1909: 62

Kaliella subturritula Germain 1921: 433

Kaliella subturritula Germain 1934: 122

Kaliella subturritula Barnacle 1962: 54

Kaliella subturritula Lionnet 1984: 241

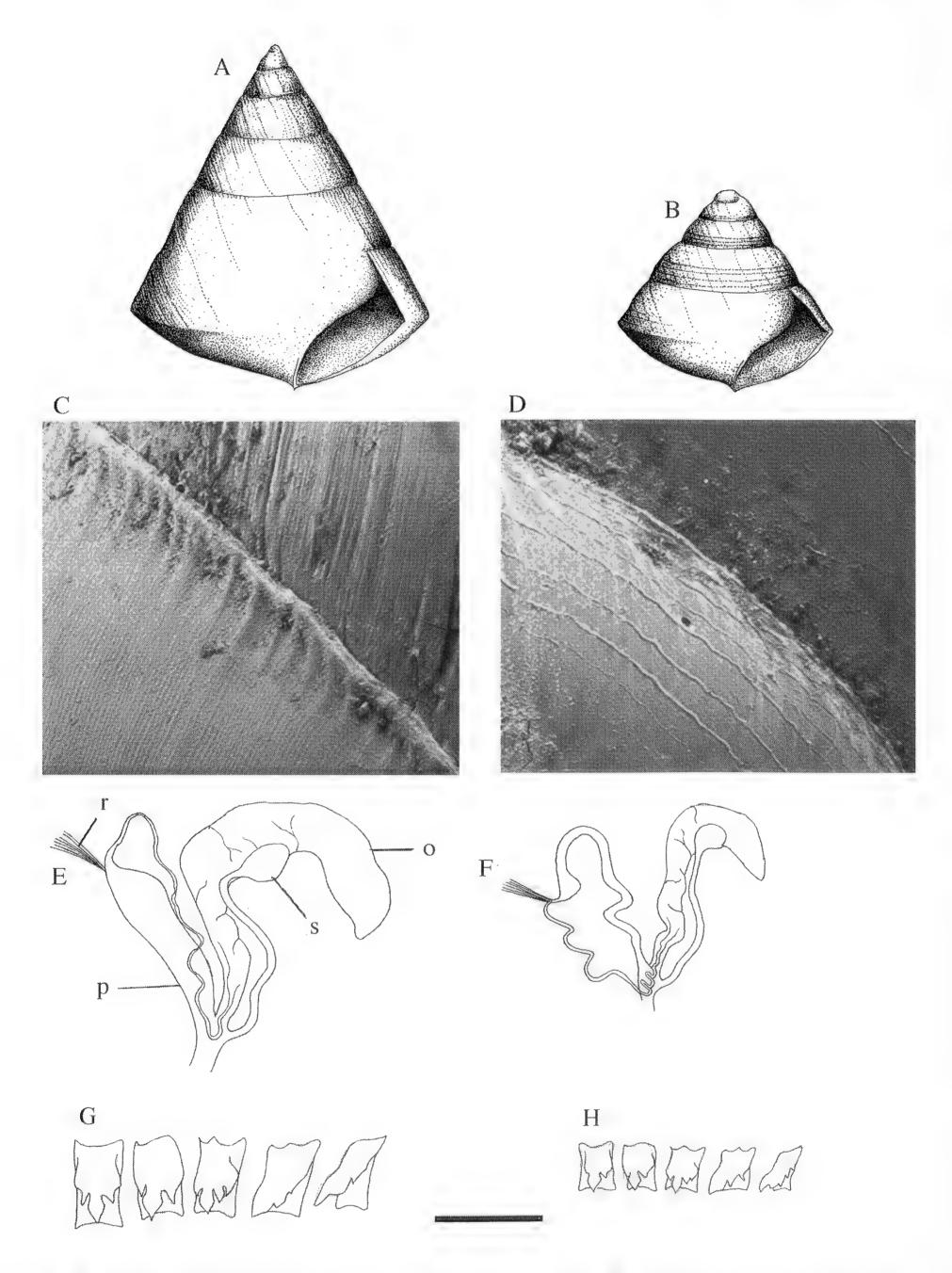
Kaliella subturritula Gerlach 1987: 17

Neotype All Nevill's Seychelles type material appears to have been lost (Barnacle, 1971), including the 6 specimens of the type series (Nevill & Nevill, 1878) of this species. Accordingly specimen NPTS M1997.1 (La Reserve, Mahé, 114188) is here designated as the neotype.

Other material Mahé 47 adults (NPTS M1997.2 (12 adults; La Reserve 21/12/86, 1/7187, 1/4188, 28/12188, 2516189, 917189; La Misere 10/8/86) and BM(NH) 1825 (35 adults, Mountain forest Cascade, Mt. Alphonse, no locality - all 1908)). Silhouette 1 adult (BM(NH) un-numbered, ex Sykes colln. 1908), 10 juveniles (NPTS M1997.3; Jardin Marron 217190-2118190).

Measurements (mm)

	Height	Diameter	Whorls	N
Holotype	4.9	4.7	6	
Range	2.9-4.9	3.1-4.7	5-6	13
Mean ±sd.	$3.89 \pm 0.64$	$3.87 \pm 0.51$	$5.5 \pm 0.46$	



**Fig. 1 A** Shell of *Nesokaliella subturritula* Scale bar = 1 mm. **B** Shell of *N. minuta* Scale bar = 1 mm. **C** Sculpture of *N. subturritula* Scale bar = 0.08 mm. **D** Sculpture of *N. minuta* Scale bar = 0.08 mm. **E** Reproductive anatomy of *N. subturritula* Scale bar = 1 mm. **o** = spermoviduct  $\mathbf{p}$  = penis  $\mathbf{r}$  = penial retractor muscle  $\mathbf{s}$  = spermatheca. **F** Reproductive anatomy of *N. minuta* Scale bar = 1 mm. **G** Radula of *N. subturritula* Scale bar = 0.01 mm, teeth C, 1, 8, 9, 14. **H** Radula of *N. minuta* Scale bar = 0.01 mm, teeth C, 1, 8, 9, 14.

Description Shell (Fig. 1A & C). Conical with 6 straight sided whorls; protoconch of 2 whorls. Whorls ornamented with fine, regular growth lines (360 mm<sup>-1</sup>) and a sculpture of microscopic regular radial ridges (60 mm<sup>-1</sup>) which are only clear on the keel of the body whorl. A sutural ridge is present on all whorls. Umbilicus open but very small (5% of shell diameter). Shell very thin, slightly glossy, translucent, with a thin, horn coloured periostracum. Mouth edge simple; columella open.

Body. Tail slightly flattened, no caudal horn. Sole tripartite. Grey with darker tenta-

cles. Mantle beige mottled with black. Mantle border beige.

Jaw. A simple plate, lateral margins angled inwards, central part horizontal.

Radula (Fig. 1G). Formula = 27+9+1+9+27.

Reproductive anatomy (Fig. 1E). Spermoviduct elongate, simple in shape. Spermatheca duct long and narrow, arising from genital atrium. Spermatheca oval, 1.5 mm longest dimension. Basal half of penis inflated, distal half elongate and very narrow, inflated terminally, total length 5 mm. No epiphallus, no penial diverticulae or ornament. Penial retractor muscle terminal.

Distribution Mahé (La Reserve, Montagne Planeau, Cascade, Mt. Sebert, Copolia, La Misere) and Silhouette (Jardin Marron, Mon Plaisir, *Pisonia sechellarum* forest). Reported from Felicite by Nevill (1870). All from forest areas above 50 m above sea level. An arboreal species.

### Nesokaliella minuta n. sp. Fig. 1

Kaliella subturritula (partim) Martens 1898: 16

Kaliella subturritula Germain 1921: 433 Kaliella subturritula Germain 1934: 122 Kaliella subturritula Lionnet 1984: 241 Kaliella subturritula Gerlach 1987: 17

Holotype NPTS M1997.4. Morne Blanc, Mahé, 30/7/87.

Paratypes NPTS M1997.5a & M1997.5b. Morne Blanc, Mahé, 30/7/87; UMZ I.22,526 (Case Dent, Mahé, 1/1/87)

Other material 14 specimens; Mahé (NPTS M1997.6; Casse Dent 1/1/87, Morne Blanc 30/7/87)

Measurements (mm)

	Height	Diameter	Whorls	N
Holotype	3.9	3.0	5	
Range	1.4-3.9	1.6-3.0	4.5-5	17
Mean ± sd.	$2.71 \pm 0.79$	$2.57 \pm 0.40$	$4.82 \pm 0.25$	

Description Shell (Fig. 1B & D) conical with 5 slightly convex whorls; protoconch of 2 smooth whorls. Sculpture of fine irregular radial growth lines (90 mm<sup>-1</sup>) and 4 fine spiral striae on posterior half of each whorl (44 mm<sup>-1</sup>). Sculpture continues onto underside. Keel sharply angled. Umbilicus open but very small (5% of shell diameter). Mouth edge simple, columella open. The shell is colourless with a thin, horn-coloured periostracum.

Body. Foot flattened caudally, no caudal horn. Light brown, tentacles darker. Sole

tripartite. Mantle brown, mottled darker.

Jaw. As N. subturritula

Radula (Fig. 1H). Formula = 39+9+1+9+39.

Reproductive anatomy (Fig. 1F). Spermoviduct elongate, slightly inflated basally. Spermatheca duct long and narrow, arising from genital atrium. Spermatheca oval, 0.75 mm longest dimension. Penis elongate (2.5 mm), narrow, folded at base and slightly inflated terminally. Penial retractor muscle terminal. No epiphallus, no penial diverticulae or omament.

Derivation of name minuta, Latin for minute.

Distribution Mahé (Mare aux Cochons, Morne Blanc, Casse Dent, Congo Rouge, Morne Seychellois, Trois Frères, Le Niol) all from forest areas above 200 m above sea level. An arboreal species.

#### ALDABRA & COETIVY 'KALIELLA'

Two species collected by the Percy Sladen Memorial Expedition 1905 on Coetivy and Aldabra were referred to *Kaliella* by Barnacle (1968) and Gerlach (1987) as 'Kaliella species A' and 'Kaliella species B' respectively. These identifications were based on manuscript notes made by Godwin-Austen, currently associated with the 1905 specimens in the BM(NH) (un-numbered specimens). Godwin-Austen referred 'Species A' from Coetivy to Kaliella with doubt, noting that it is probably anatomically distinct from that genus. Only one of the two specimens is complete and appears to be a species of Euconulidae and may be an introduced species of Liardetia. No further specimens have been collected. Species B is represented by numerous specimens in the BM(NH) and in the private collection of G. Lionnet. Godwin-Austen's identification of this taxon as a Kaliella species may be correct but this cannot be determined in the absence of spirit material.

#### **ACKNOWLEDGEMENTS**

I am grateful to W. Lee for preparing the scanning electron microscope photographs and to Dr B. Verdcourt for reviewing the manuscript and drawing my attention to my original mistaken family designation.

#### REFERENCES

Baker H.B. 1941 Zonitid snails from Pacific Islands (parts 3 & 4) Bulletin of the Bernice P. Bishop Museum 166: 203–370.

Barnacle G.A.S. 1962 The land and freshwater shells of the Seychelles *Journal of the Seychelles Society* **2**: 53–57.

BARNACLE G.A.S. 1971 Note on a streptaxid from Seychelles *Imperturbatia levieuxi* (Nevill and Nevill) *Journal of Conchology* **26**: 386–387.

Blanford W.T. 1863 On Indian Species of Land-Shell belonging to the Genera *Helix*, Linn., and *Nanina*, Gray *Annals & Magazine of Natural History* 11 (3): 81–86.

GERLACH J. 1987 The Land Snails of Seychelles - a field guide Privately published 43 pp.

GERMAIN L. 1921 Mission Zoologique de M. Paul Carie aux îles Mascareignes: faune malacologique

22

terrestre et fluviatile des îles Mascareignes Gaultier & Thébert, Angers.

GERMAIN L. 1934 L'origine de la composition de la faune malacologique des îles Séchelles Comptes rendus du Congres des Societes des Savants du Paris. Section des Sciences 16: 113–133.

GOETHEM J.L. VAN 1977 Révision systématique des Urocyclinae (Mollusca, Pulmonata, Urocyclidae) Annales du Musée Royal de l'Afrique Centrale 218: 1–355.

LIONNET G. 1984 Terrestrial testaceous molluscs of the Seychelles. *In* Stoddart D.R. (ed) *Biogeography and ecology of the Seychelles Islands* Dr W. Junk, The Hague pp. 239–244.

Martens E. von 1898 Land und Susswasser-mollusken der Seychellen Mitteilungen aus dem Zoologischen Museum. Berlin 1: 1–96.

NEVILL G. 1868 Notes on some of the species of land mollusca inhabiting Mauritius and the Seychelles *Proceedings of the Zoological Society of London* **1868**: 257–261.

NEVILL G. 1870 Additional notes on the land-shells of the Seychelles Islands *Proceedings of the Zoological Society of London* for **1869**: 61–66.

NEVILL G. 1878 Handlist of the Mollusca in the Indian Museum Calcutta. 1. Gastropoda Indian Museum, Calcutta.

NEVILL G. & NEVILL H. Descriptions of new mollusca from the eastern regions *Journal of the Asiatic Society of Bengal* **40** (2): 1–11.

Pilsbry H.A. 1919 Land Mollusks of the Belgian Congo Bulletin of the American Museum of Natural History 40: 1–370.

Pilsbry H.A. 1946 Land Mollusca of North America (north of Mexico) 2 (1): 246–425. Academy of Natural Sciences of Philadelphia, Pennsylvania. Monograph 3.

Sykers E.R. 1909 The land and freshwater mollusca of the Seychelles Archipelago *Transactions of the Linnean Society of London (Zoology)* **13**: 57–64.

TILLIER S. 1989 Comparative morphology, phylogeny and classification of land snails and slugs (Gastropoda: Pulmonata: Stylommatophora) *Malacologia* **30** (12): 1–303.

### A NEW SPECIES OF PUNCTIDAE (MOLLUSCA: GASTROPODA) FROM SEYCHELLES

J. GERLACH<sup>1</sup>

Abstract A species of Punctum is recorded from moss forest on the islands of Mahé and Silhouette, Seychelles. This is described as a new species.

Key words Punctum, Mahé, Silhouette.

#### Introduction

Collections of Seychelles molluscs made since 1987 have included small numbers of a very small species of endodontoid. This species is identifiable as a species of *Punctum*, a genus which has not been reported from Seychelles or other islands of the western Indian Ocean. All known specimens have been collected from the highest moss forest areas which are characterised by the high degree of endemism in their faunas, of which the mollusc faunas are known to be entirely composed of endemic species. This biogeographical factor indicates that the *Punctum* is likely to be a new species which has been overlooked by earlier collectors due to its small size.

Reliable identification of species in this genus is difficult due to the lack of any recent monographic treatment and difficulties in obtaining sufficient material, in particular spirit material. For the Seychelles species a series of shells was collected through sieving and through the use of a Winkler apparatus. A live specimen was observed on only one occasion but this animal was preserved retracted. During dissection of this specimen the reproductive anatomy could not be located and the radula was lost, however, the characterisite endodontoid jaw plates were located. All descriptions of African, Asian and Australasian Punctidae were consulted in order to provide a provisional identification. The Seychelles species could not be assigned to any of these taxa and a new species name is proposed below.

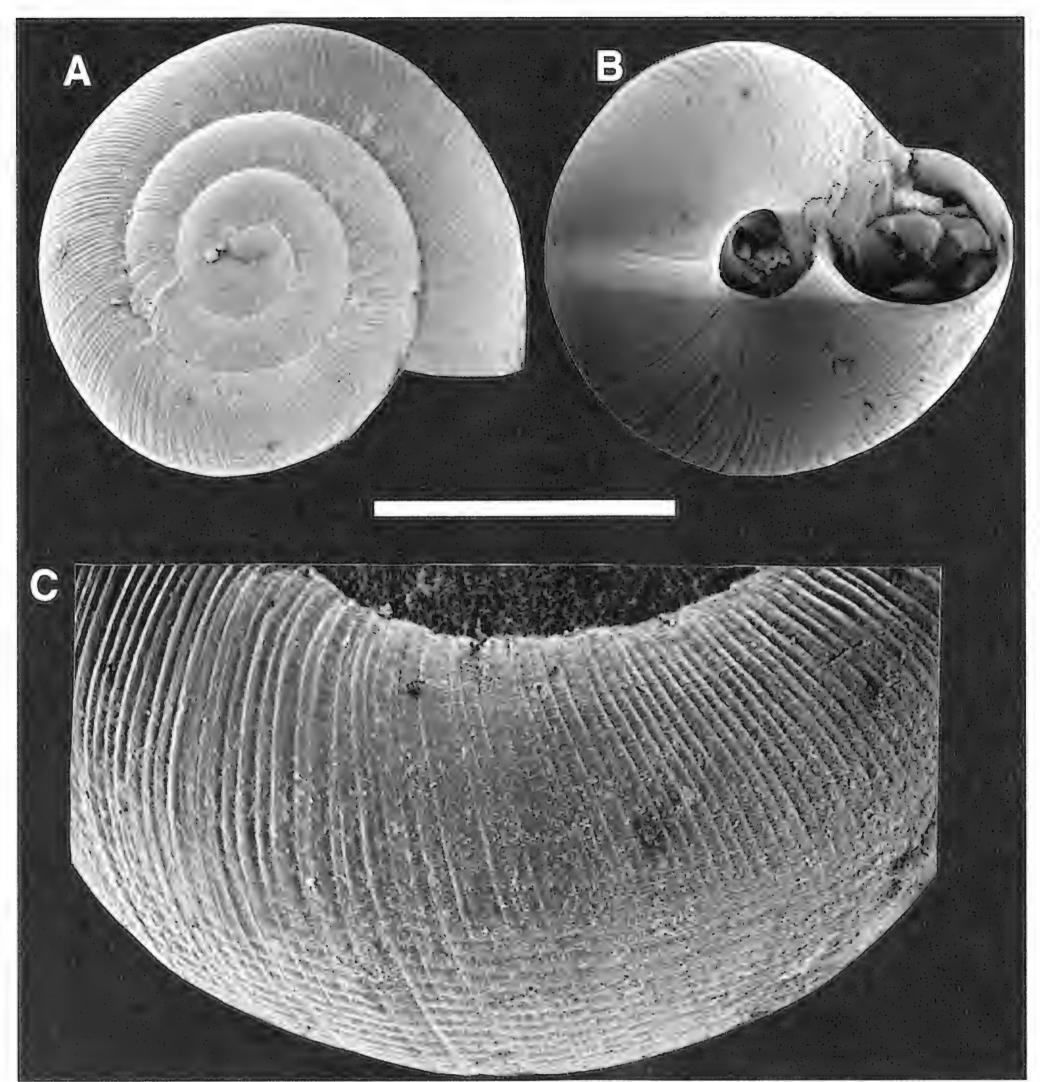
#### **ABBREVIATIONS**

NPTS Nature Protection Trust of Seychelles UMZ University Museum of Zoology, Cambridge

#### COMPARISIONS WITH OTHER TAXA

Examination of descriptions and specimens of African, Asian and Australasian endodontoids (in the broad sense as in Verdcourt, 1991) shows that few species share the spiral sculpture of the Seychelles specimens. Of the African species, all those with spiral striae (e.g. *P. cryophilum* (Martens, 1865), *P. hottentotum* (Melvill & Ponsonby, 1891) *P. pallidum* Connolly, 1922, *P. kilimanjaricum* Verdcourt, 1978) have higher spires with the exception of *P. ugandanum* (E.A. Smith, 1903). *P. ugandanum* also has the spiral sculpture but the striae are curved, unlike the Seychelles species.

<sup>&</sup>lt;sup>1</sup> 53 River Lane, Cambridge CB5 8HP, UK.



**Figure 1 A & B** Shell of *Punctum seychellarum* Scale bar = 0.5 mm. **C** Sculpture of *P. seychellarum* Scale bar = 0.2 mm.

The only similar Australasian species are *Charopa benhami* (Suter, 1909) which differs in its broader umbilicus (30%) and *C. ochra* (Webster, 1904) which has fewer ribs and a yellow body. Many species have been synonymised with *Paralaoma caputspinulae* (Reeve, 1852) (Gittenberger *et al.* 1980, Roth 1987), however this bears little resemblance to the Seychelles species. Compared to the Seychelles species *P. caputspinulae* has a coarser sculpture of distinctly S-shaped radial ridges (20 times fewer ridges per millimetre) and a much broader umbilicus (50% of shell diameter, compared to 24%).

The body colour of the Seychelles species is very unusual for a punctid, being scarlet. Although most endodontoids are brown or grey a small number of species have been described as bright yellow (*Charopa ochra* (Webster, 1904) and *Allodiscus urquharti* Suter, 1894) or orange (*Charopa chrysaugeia* (Webster, 1904). The apparent scarcity of brightly coloured endodontoids may be due to the rarity of fresh material and the rapid fading of these colours in preserved material.

### Punctum seychellarum n. sp. Fig. 1

Holotype Pisonia sechellarum forest, Silhouette; 21/8/90. NPTS M1997.7.

Paratypes Pisonia sechellarum forest, Silhouette; 21/8/90. NPTS M1997.8, UMZ I22.450.

Other material 1 specimen Mahé (NPTS M1997.9, Congo Rouge 318189), 1 specimen Silhouette (NPTS M1997.10 Pisonia sechellarum forest 21/8/90).

Measurements (mm)

		Height	Diameter	Whorls	N
Holotype		1.2	3.2	4	
Mahé	Range	0.6	1.2	4	1
Silhouette	Range	0.6 - 1.2	1.0 - 3.2	3.5-4	4
	Mean $\pm$ sd.	$0.83 \pm 0.26$	$1.60 \pm 1.10$	$3.62 \pm 0.25$	

Description Shell (Fig. 1.) Minute discoidal shell with 3.5–4 whorls, protoconch of 1.5 flat whorls. Apex not raised. Sculpture of protoconch finely pitted (pits 0.008 mm diameter), body whorls omamented with regular radial ridges (93 mm<sup>-1</sup>) and microscopic spiral striae (242 mm<sup>-1</sup>). Sculpture continues on the underside of the shell. Umbilicus open, relatively narrow (24% of diameter) but open to apex of shell. Keel rounded. Aperture rounded, simple. Shell colourless to horn-coloured.

Body. Scarlet in life, fading to beige in spirit.

Anatomy. Unknown except for the jaw which is composed of 15 plates.

Derivation of name seychellensis from the country of origin of the specimens.

Distribution Seychelles; Mahé (Congo Rouge, primary moss forest 700 m above sea level), Silhouette (*Pisonia sechellarum* primary moss forest, 550 m above sea level).

#### **ACKNOWLEDGEMENTS**

I am grateful to Dr B. Verdcourt for providing a starting point by identifying the specimens as *Punctum* and to W. Lee for preparing the scanning electron microscope photographs.

#### REFERENCES

GITTENBERGER E., MENKHORST H.P.M.G. & RAVEN J.G.M. 1980 New data on four European terrestrial gastropods *Basteria* 44: 11–16.

ROTH B. 1987 'Punctum pusillum' (Gastropoda: Pulmonata: Punctidae) a correction The Veliger 30: 95–96.

VERDCOURT B. 1991 Some notes on East African endodontoid snails - Part 1 *The Conchologists' Newsletter* **116**: 352–359.

Webster W.H. 1904 New Mollusca from New Zealand *Proceedings of the Malacological Society* 6: 106–108.

## ON THE SYSTEMATIC POSITION OF ARABOXYCHILUS SABAEUS (GASTROPODA: PULMONATA) FROM THE SOUTH-WEST OF THE ARABIAN PENINSULA

#### BARRY COLVILLE<sup>1</sup> & ADOLF RIEDEL<sup>2</sup>

Abstract Examining the anatomy of the monotypic Araboxychilus Riedel, 1977 revealed that it should be included as a subgenus in the genus Oxychilus Fitzinger, 1833 (Zonitidae - Oxychilinae). Thus there is a small, isolated distribution area of the Zonitidae in the south-west of the Arabian Peninsula, rather remote from the continuous distribution range of the family.

Key words Oxychilus sabeus, Arabian peninsula.

Martens (1889) described from "Menaha" (= Manakha in N. Yemen) a snail "Trochomorpha" sabaea (the genus Trochomorpha actually belongs to the family Trochomorphidae) which Hesse (1914), based on scanty anatomical data, transferred to the "genus Hyalinia, group H. cellaria" (= Oxychilus Fitzinger, Zonitidae). Riedel (1977: 509–511) introduced for this species a monotypic genus Araboxychilus, including it in the Zonitidae, Oxychilini (at present: Oxychilinae), albeit with some reservations (the structure of genitalia was practically unknown). At the same time he presented the history of studies on the species and various attempts at its classification.

Dr A. Zilch (SMF) wrote to Riedel on September 16th 1980, about *Araboxychilus* "Ich halte Ihre Gattung für berechtigt, aber vielleicht hat Moellendorff [in litt. - A.R.] gar nicht so unrecht wenn er die Art zu den Macrochlamydinae [genus *Bensonia* L. Pfeiffer = at present *Bensonies* H.B. Baker] stellt. Aus tiergeographischen Gründen würde das gut

passen und ist zu prüfen".

In view of: 1. unknown structure of the genitalia; 2. remoteness of the area from the southern border of the continuous distribution range of the Palaearctic Zonitidae (almost 2000 air km); 3. conchological similarity with oriental non-zonitids, the doubts as to familial appurtenance were grounded. These doubts have been recently expressed by Riedel (1997).

For over a hundred years *Araboxychilus sabaeus* remained the only possible, but still uncertain member of the family Zonitidae on the southern margin of Arabian Peninsula. Only recently a second, conchologically quite different zonitid (?) species has been found in the south-west of Saudi Arabia. Its description will be included in the paper now prepared by Dr E. Neubert. Regretfully, it is known only from its shell. For comparative purposes we had at our disposal two specimens of the type series (MIZ-PAS, Warszawa). In March 1997 one of us (B.C.) collected in N. Yemen live specimens of *Araboxychilus sabaeus*. The latter material is the basis of our paper. It permits a definitive statement as to the appurtenance of the discussed snail to the Zonitidae-Oxychilinae, and the existence of an isolated (today, and what about the past? - cf. Riedel 1997) southern part of the distribution of the Zonitidae on the Arabian Peninsula.

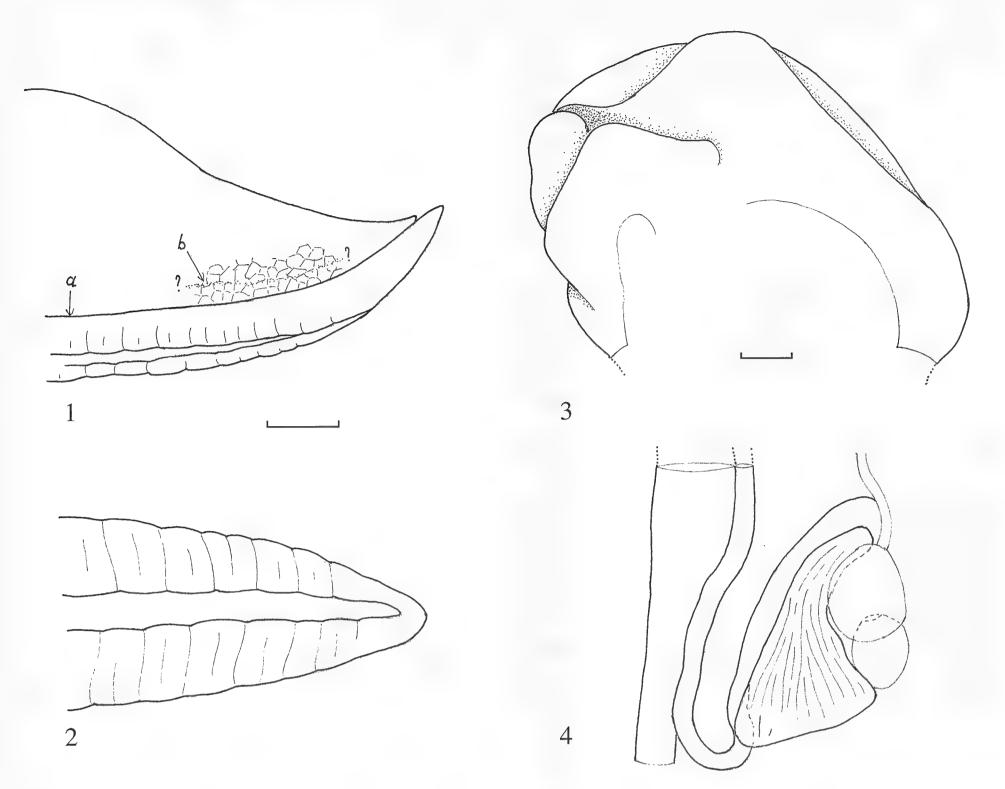
#### ZONITIDAE Oxychilinae

#### Oxychilus (Araboxychilus) sabaeus (Martens, 1889)

*Material examined* 2 specimens in alcohol (both dissected) at MIZ (Museum and Institute of Zoology); further specimens at the British Museum (Natural History) and collection Colville. Footpath from Kawkaban to Shibam, Al-Mahwit province N. Yemen. 6.03.1997 B. Colville leg.

<sup>&</sup>lt;sup>1</sup> Pool Foot, Clappersgate, Ambleside, Cumbria, LA22 9NE, UK.

<sup>&</sup>lt;sup>2</sup> Museum and Institute of Zoology, Polish Academy of Sciences, Wilcza 64, 00-679 Warszawa, Poland.



**Figs 1–4** Oxychilus (Araboxychilus) sabaeus 1 posterior end of foot in side view (**a** pedal groove **b** purported suprapedal groove) 2 posterior end of sole 3 mantle, viewed from underside 4 pallial complex viewed from underside (heart, kidney, ureter, rectum). Scale bar = 1 mm.

Description Body, including sole, steel blue (somewhat lighter on sides), only mantle light, creamy. Mantle with no shell lobe, left neck lobe undivided (Fig. 1). Gonopore remote from the basis of the right ommatophore. Pedal groove very distinct, deep, suprapedal groove barely visible (only when one is very keen on seeing it - A.R.). Posterior end of foot tapered, with no trace of caudal "horn" (Fig. 1), no distinct caudal pit. Sole divided by grooves into three longitudinal stripes (Fig. 2).

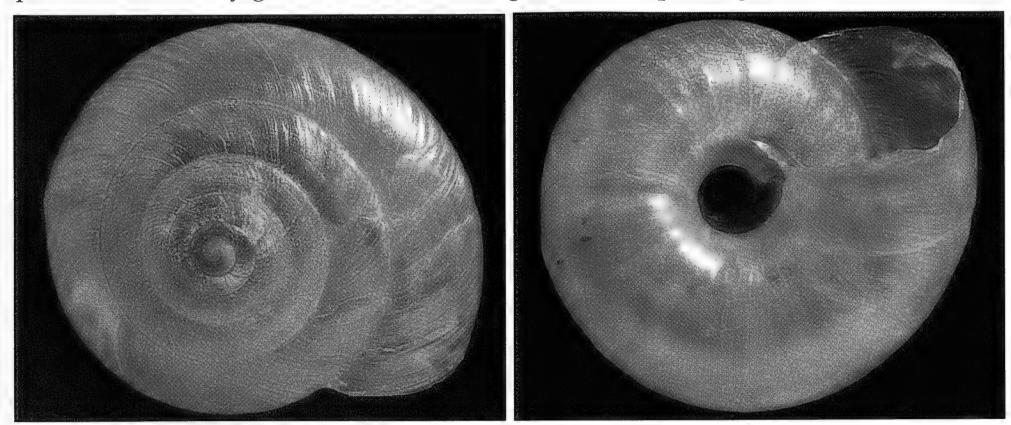
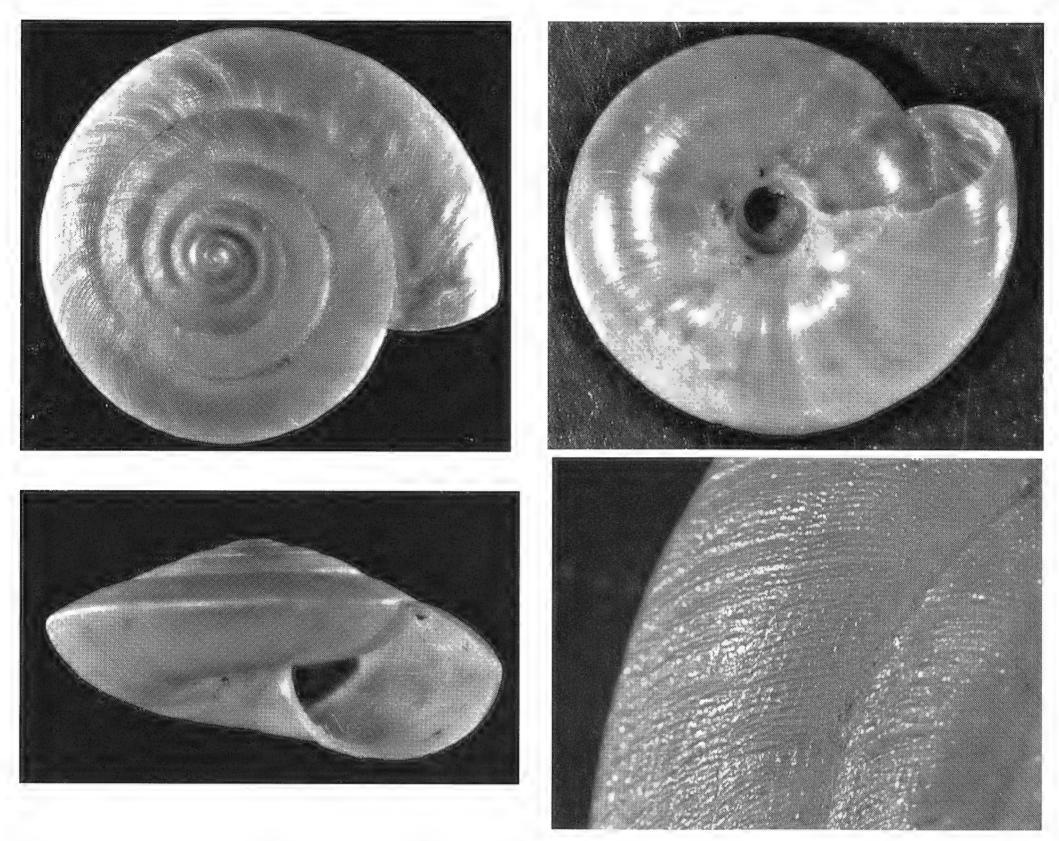


Fig. 5 Dorsal and ventral views of the shell of Oxychilus (Araboxychilus) sabeus



**Fig. 6** Oxychilus (Araboxychilus) sabaeus. Paratype of Trochomorpha sabaea Martens, 1889. Collection of the Museum and Institute of Zoology, PAS, Warsaw. Shell width 16.2 mm.

Pallial complex (Figs 3, 4) like in other zonitids. Right ommatophore retractor crosses genitalia (it runs in an angle formed by penis and vagina).

Shell (Figs 5, 6) (see description in Martens 1889 and Riedel 1977) in accordance with the paratypes of this species that are kept at the Museum in Warsaw, but considerably smaller (probably specimens not fully adult). In one of the specimens the shell breadth was 13 mm, at  $5^{2}$ /3 whorls, in the other almost 12 mm, at  $5^{1}$ /2 whorls; shells of the type series reach 20 mm breadth and up to  $6^{1}$ /2 whorls, though Martens gives 17.5 mm and 6 whorls. In spite of this the genitalia of the examined specimens were well developed, though perhaps not definitively mature, especially their female parts.

Snail body shines through the underside of the shell, heart and kidney being especially well visible.

Genitalia (Figs 8, 9) typical of the genus Oxychilus Fitzinger. Penis long, together with flagellum much longer than the oviduct and vagina combined. Terminal flagellum long, forming c.  $\frac{1}{3}$  length of the entire penis. Penial retractor muscle inserted at the top of flagellum. Proximal  $\frac{1}{3}$  of the penis cylindrical, hidden in a sheath, mid  $\frac{1}{3}$  in its distal part irregularly folded, thin-walled, internal structures slightly shining through the walls. Epiphallus roughly equal to penis without flagellum or somewhat shorter, opens to penis laterally and is clearly delimited from vas deferens. In the region where vas deferens passes into epiphallus a free, distal margin of penis sheath is fixed. Vas deferens rather short.

Atrium genitale is not delimited. Vagina and free oviduct of roughly equal length or

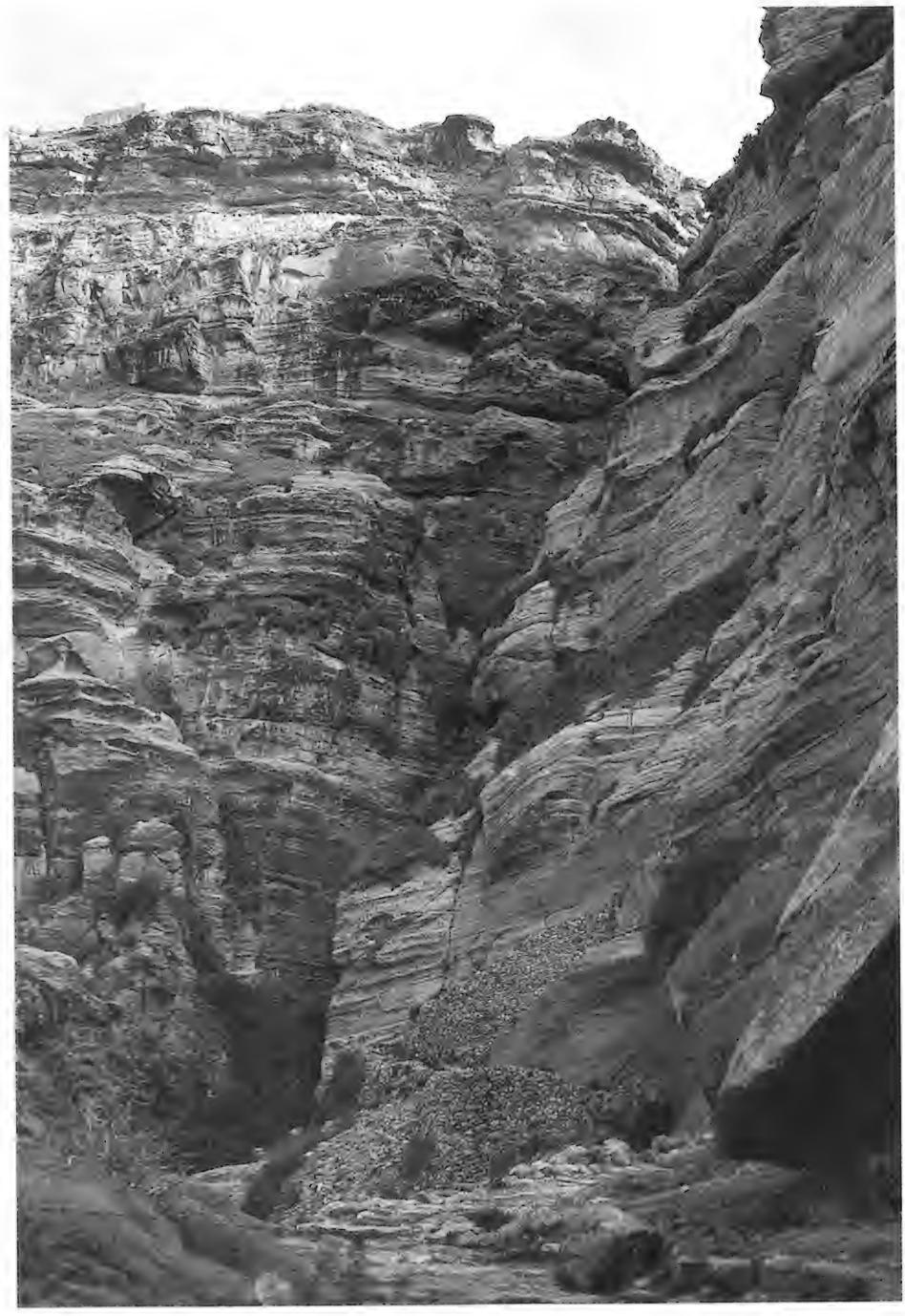


Plate 1 Upper part of the path from Kawkaban, on top of Jebel Kawkaban, to Shibam.

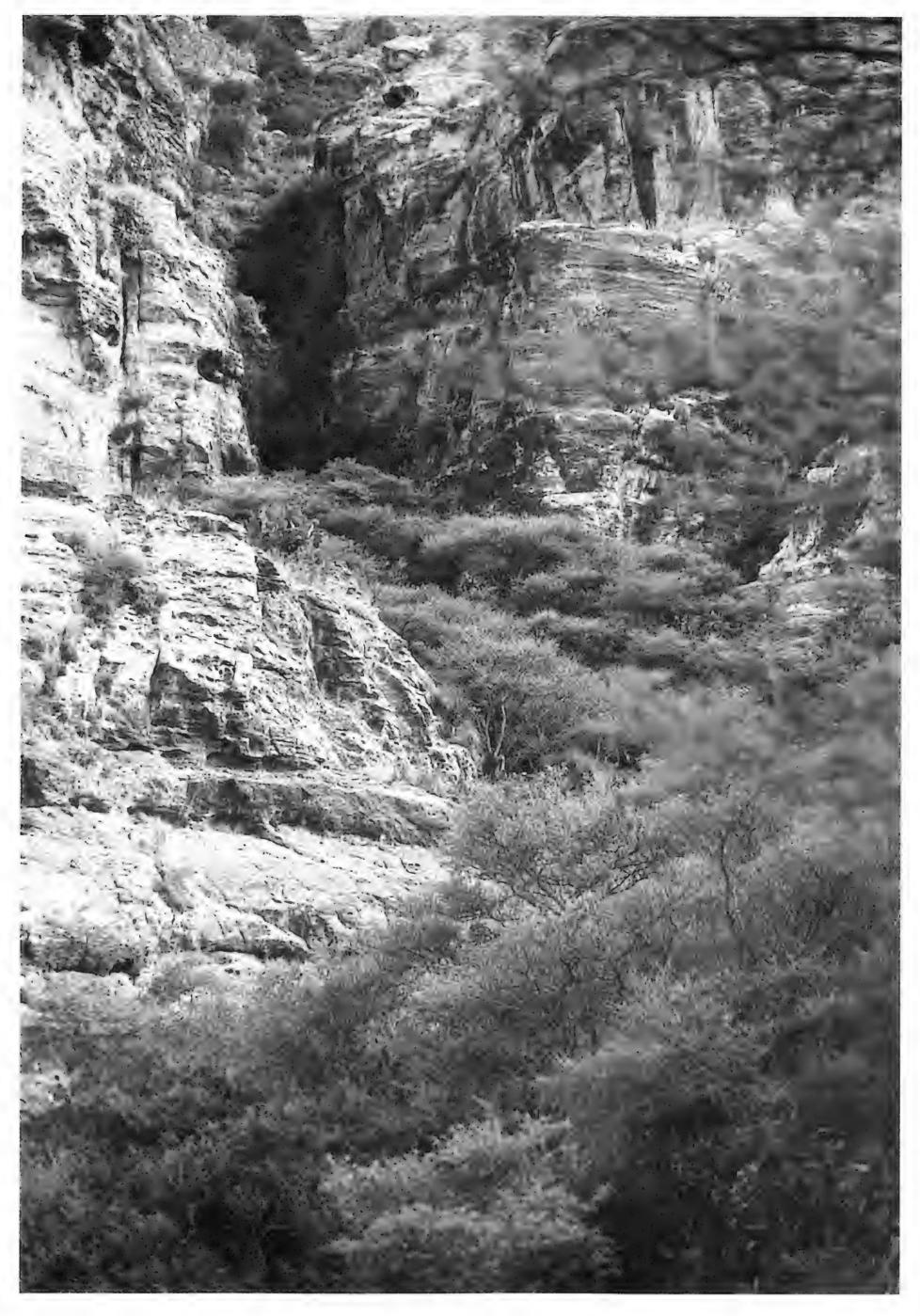
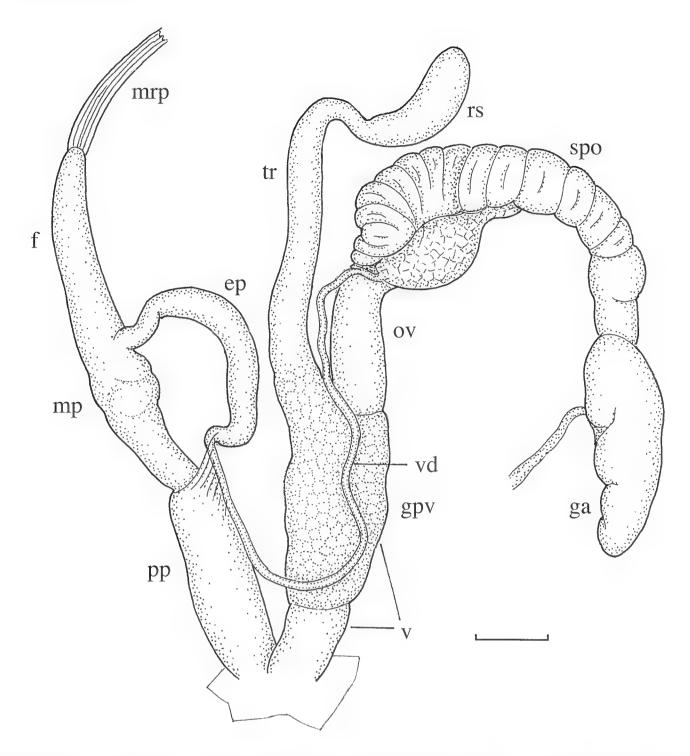


Plate 2 Habitat of Oxychilus sabeus from path between Kawkaban and Shibam, Yemen.



**Fig. 7** *O.* (*Araboxychilus*) *sabaeus* genitalia of the larger specimen (**mrp** penial retractor muscle **f** flagellum = distal part of penis **mp** mid part of penis **pp** proximal part of penis in the penis sheath **ep** epiphallus **rs** spermatheca **tr** spermatheca duct **vd** vas deferens **v** vagina **gpv** perivaginal gland **ov** free oviduct **spo** spermoviduct **ga** albumen gland). Scale bar = 1 mm.

free oviduct somewhat shorter. Vagina, except its proximal end, covered with a big perivaginal gland which reaches rather far on the base of spermatheca duct. Spermatheca duct with a rather small, narrow spermatheca, very long, more or less the same length as penis combined with flagellum. Spermoviduct narrow, albumen gland small and narrow, with a well visible talon (Fig. 9) - juvenile condition?

No distinct accessory penial gland was found in the reproductive system; such a gland was mentioned by Pfeffer (1930: 412 - "eine ausserordentlich grosse

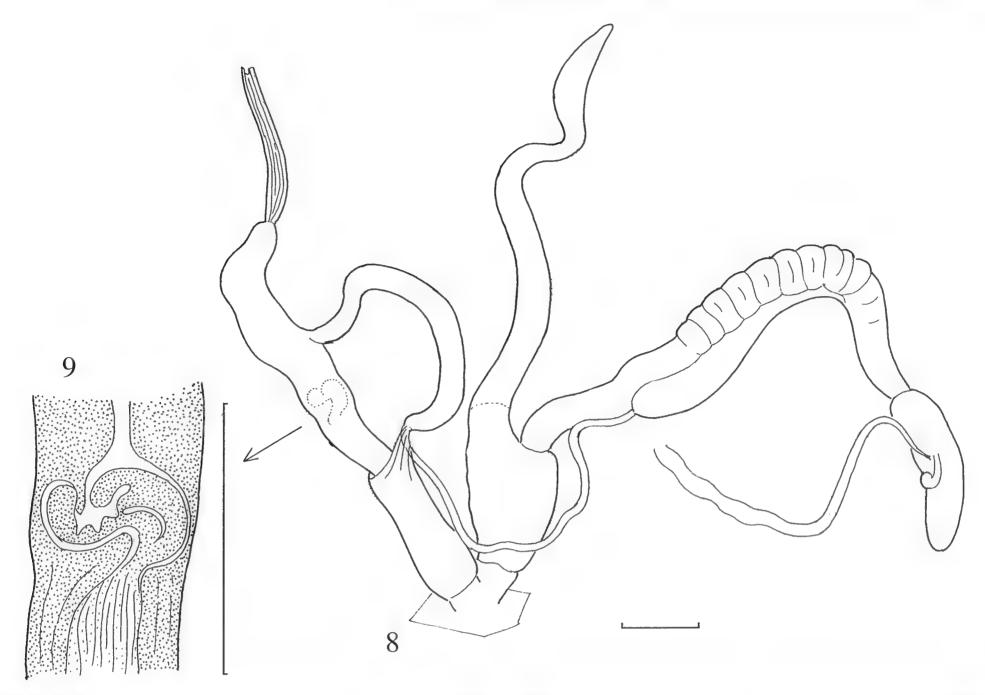
Anhangsdrüse des Penis"), but perhaps this was an erroneous observation.

The internal structure of the penis was examined in one of the specimens, directly, after cutting along the penis walls; in the other on a total microscopic slide cleared in xylol and embedded in cedax. In the proximal part (covered with the sheath), on inner walls there are narrow longitudinal folds, grouped in twos and threes close to each other. In the mid part, close to the epiphallus outlet, the folds merge into a large, coiled, complicated structure, which is situated more or less transversely in the penis and dividing its lumen in two distinct parts (Fig. 9); it shines through the penis walls. In the flagellum there are two flat, wide, smooth longitudinal folds and two obliquely segmented longitudinal swellings, whose proximal ends surround the epiphallus outlet. There are no papillae or spines.

Radula (Fig. 10), examined in one of the specimens, is typical of the Zonitidae-

Oxychilinae. Formula:

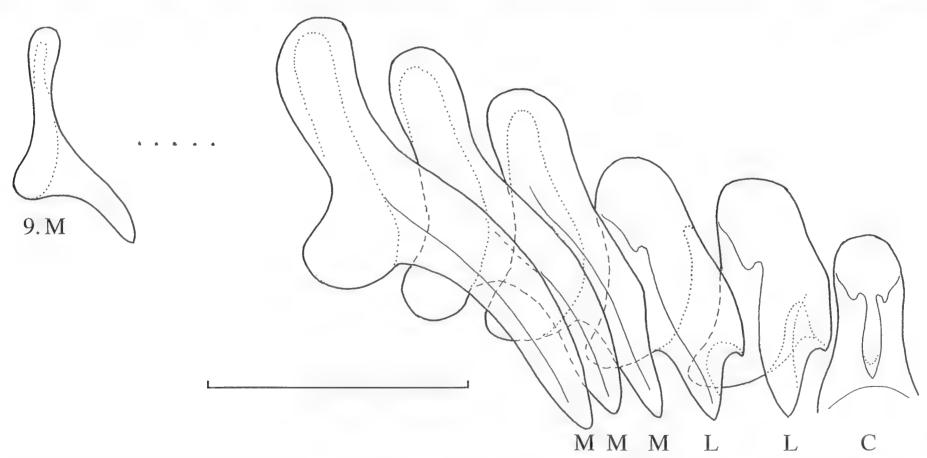
 $11 \text{ M}/1 + 2 \text{ L}/3 + \text{C}/3 + 13 \times 38$ 



**Figs 8 & 9** *O.* (*Araboxychilus*) *sabaeus* **8** genitalia of the smaller specimen **9** septum in the penis lumen, semidiagrammatic view of the preparation cleared in xylol. Scale bar = 1 mm.

Central plate with a long, slender mesocone, marginal plates thorn-shaped, simple, unicuspid.

To sum up. The structure of genitalia, radula etc. (e.g. mantle) are so typical of the genus *Oxychilus* Fitzinger, that we include *Araboxychilus* as a subgenus into *Oxychilus* (in the neighbourhood of the subgenera *Ortizius* Forcart and *Longiphallus* cf. Riedel 1980 & 1998 in press). The main diagnostic characters distinguishing this monotypic subgenus are: 1. shell, 2. different internal structure of penis with a distinct transverse "septum" that divides its lumen into proximal part and distal part, comprising mostly flagellum.



**Fig. 10** *O.* (*Araboxychilus*) *sabaeus* A fragment of radula (**C** central plate L lateral plates **M** marginal plates). Scale bar = 0.1 mm.

Distribution and habitat O. (A.) sabaeus seems to be rather common in the mountains of Yemen; at least it was repeatedly recorded from various sites at c. 2000–3000 m a.s.l. (Connolly 1941: 19 sub Zonites(?) sabaeus, Riedel 1977: 510). In Al Mahwit it was found beside a good ancient pathway and steps down the north facing cliff (Plates 1, 2) between the village of Kawkaban and the town of Shibam, 18 km NW of Sana'a, in sparse vegetation in fissures under boulders and on ledges, between 2,600 and 2,750 m a.s.l. It was found there together with another "zonitidomorph" snail - Gudeella rufocincta Connolly, which however, judging from the description of foot and radula by Connolly (1941), belongs to Macrochlamydinae (Helicarionidae = +-Ariophantidae). Other species present were: an unrecognized pupilloid, an enid Cerastus schweinfurthi (Kobelt), two vitrinids one of which was Arabivitrina arabica (Thiele), a clausiliid Macroptychia sumerana (Connolly) and a helicid Lejeunia leucostriata (Von Martens).

#### **ACKNOWLEDGEMENTS**

We are grateful to Dr Peter B. Mordan (London) for preserving the material and sending it to one of us (A.R.). We thank Dr Beata M. Pokryszko (Wrocław) for her help with the text. We are indebted to Prof. Dr Folco Giusti (Siena) for his suggestions and criticisms.

#### REFERENCES

- CONNOLLY M. 1941 South Arabian non-marine Mollusca. *In Expedition to South-West Arabia* 1937–8 I, 4. British Museum (N.H.), London pp. 17–42, 8 Figs, pl. 3.
- HESSE P. 1914 Kritische Fragmente Nachrichtsblatt der Deutschen Malakozoologishen Gesellschaft Frankfurt-am-Main 46: 59–64, 4 Figs.
- Martens E. von 1889 Ueber südarabische Landschnecken. Nachrichtsblatt der Deutschen Malakozoologishen Gesellschaft Frankfurt-am-Main 21: 145–153.
- Pfeffer G. 1930 Die Unterfamilie Zonitinae (Moll., Pulm.). Mitteilungen aus dem Zoologishen Museum in Berlin 16: 411–507, 3 Figs, pls. 4–6.
- RIEDEL A. 1977 Materialien zur Kenntnis der Zonitidae (Gastropoda). IX–XI. *Annales Zoologici*. Instytut Zoologiczny, Polska Akademia Nauk. Warszawa 33: 495–515, 22 Figs, 1 pl.
- RIEDEL A. 1980 Genera Zonitidarum. Diagnosen supraspezifischer Taxa der Familie Zonitidae (Gastropoda, Stylommatophora) Dr W. Backhuys, Rotterdam 197 pp., 294 ff., 2tt.
- RIEDEL A. 1997 The Zonitidae (sensu lato) on the south-eastern and south-western borders of their Palaearctic distribution area (Gastropoda, Stylommatophora) Heldia. München 4: 98–100.
- Riedel A. 1998 Genera Zonitidarum Addenda et corrigenda Warszawa (in press).

## A NEW SPECIES OF GARI (GOBRAEUS) (BIVALVIA, TELLINOIDEA, PSAMMOBIIDAE) FROM BAHIA COAST, BRAZIL

#### L.R.L. SIMONE<sup>1</sup>

Abstract Gari (Gobraeus) linhares n. sp. is described based on two whole shells collected in Salvador, Bahia, Brazil. The genus is reported for the first time from the Western Atlantic.

Key words Gari linhares n. sp., Psammobiidae, Brazil.

#### Introduction

The family Psammobiidae is represented in the Caribbean Sea by three species [Sanguinolaria sanguinolenta (Gmelin, 1791); Asaphis deflorata (Linné, 1758) and Heterodonax bimaculatus (Linné, 1758)] (Warmke & Abbott, 1962) and on the Brazilian coast by S. cruenta (Lightfoot, 1796) as well as the three above cited species (Rios, 1994). Species of the genus Gari Schumacher, 1817 [type G. vulgaris (= Solen amethystus Wood, 1815)] were, until now, not known from the Western Atlantic area (Abbott, 1974).

From a project designed by professional and amateur malacologists to extend the knowledge on the malacofauna from Bahia State, Brazil, several new occurrences and species have been discovered. This paper reports on one of those discoveries, a rare, infratidal bivalve belonging to genus *Gari* reported for first time in the Western Atlantic.

Species of *Gari* are relatively abundant on the west coast of North and Central America with Keen (1971) listing seven species. In the Eastern Atlantic, including the Atlantic coast of Europe, the Mediterranean Sea and the West Africa coast, 10 *Gari* species occur (Nicklès, 1950; Cosel, 1989; Poppe & Gotto, 1993). The present discovery is the first to record the genus from the north-western Atlantic.

The genus *Gari* groups several subgenera (Moore, 1969: 631; Willan, 1993), and of these, the present species has an affinity to *Gobraeus* Brown, 1844 (type *Solen vespertinus* Gmelin, 1791).

No information on the inner anatomy is possible with the available material, which consists of shells only.

#### **S**YSTEMATICS

TELLINOIDEA PSAMMOBIIDAE

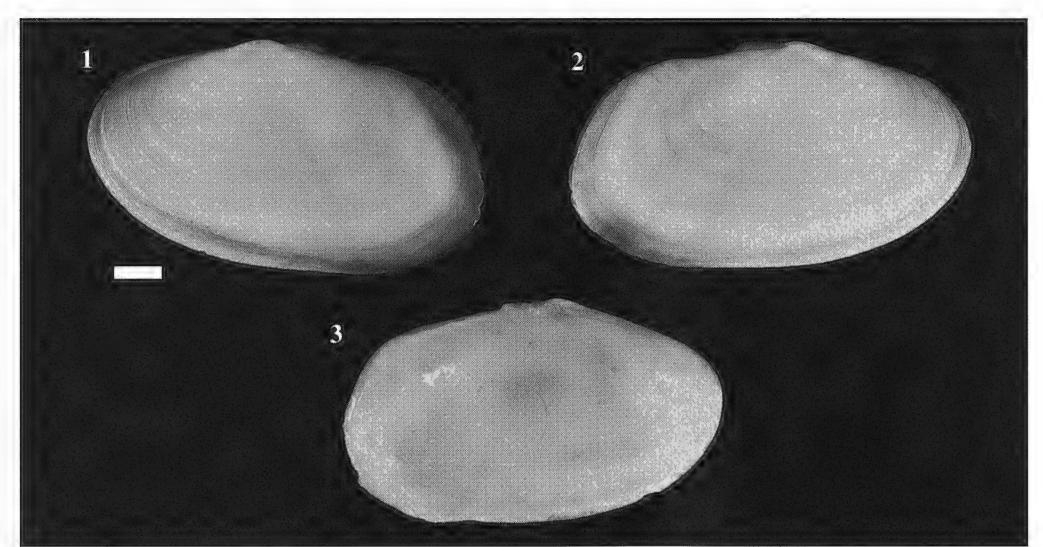
Gari (Gobraeus) linhares n. sp. Figs 1–4

Holotype From Museu de Zoologia da Universidade de São Paulo, MZSP 28785.

Paratype MZSP 28786.

Type locality Brazil, Bahia, Salvador city, off Barra beach, about 5 m depth.

<sup>1</sup>Museu de Zoologia da Universidade de São Paulo, Cx. Postal 42694, 04299-970 São Paulo, SP, Brazil E-mail: lrsimone@usp.br.



**Figs 1–3** *Gari (Gobraeus) linhares* n. sp. 1 Holotype, lateral view of left valve 2 same, right valve 3 Paratype, inner view of left valve. Scale = 5 mm.

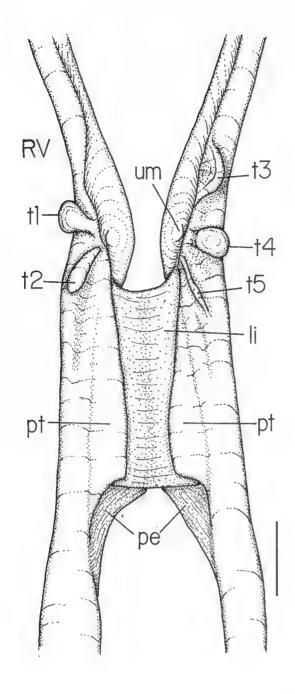
*Measurements* Respectively length, height and width in mm. Holotype: 44.5 by 25.0 by 13.3; paratype: 40.7 by 25.7 by 12.8.

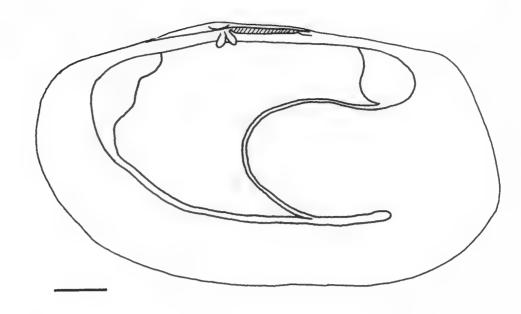
Description Shell of medium size (up to 50 mm), elliptical, laterally compressed, equivalve; umbo central; colour opaque, white near umbo, gradually become pale beige towards margins with one or two posterior radial bands. Periostracum very scanty, only present near ventral and posterior margins, thin, velvet-like, dark brown. Anterior margin somewhat similar to posterior margin, but narrower and more rounded. Sculpture of concentric, shallow undulations and growth lines (Figs 1–2); posterior slope with superficial oblique-radial striae. Pedal aperture very narrow. Ligament just posterior to umbo, set on a shelf-like nymph (Fig. 4: pt). Hinge of right valve (RV) with a pair of somewhat similar, divergent, tall cardinal teeth (t1, t2). Hinge of left valve with three cardinal teeth; anterior tooth tall, laminar, concave in dorsal surface (t3), in a shallow concavity of RV, this articulation restricted to its dorsal surface; middle tooth tall, triangular, tip broader than its base (t4), fitting between both cardinal teeth of RV; posterior tooth long, oblique, ridge-like, shallow (t5), fitting in a shallow furrow of RV. Anterior adductor scar large, somewhat triangular (Fig. 3). Pallial line well marked; pallial sinus large, about half width of shell, anterior limit below beaks; lower limb of pallial sinus confluent with pallial line for half its length. Posterior scar of adductor muscle rounded, somewhat small (about half of anterior scar area), situated approximately in middle level of postero-dorsal margin.

Derivation of name The name refers both to its discoverer, Bernardo Linhares de Albuquerque, and the Latin *linea* (line) referring to concentric undulations of its sculpture.

Habitat The double-valved shells were collected on sand near rocks, about 5 m depth.

Geographic range Known only from type locality.





**Fig. 5** *Gari (Gobraeus) linhares* n. sp., right valve, inner view, showing muscular scars. Scale = 5 mm.

**Fig. 4** *Gari (Gobraeus) linhares* n. sp., detail of hinge in *camera lucida*. Scale = 2 mm. Abbreviations: **li** ligament; **pe** periostracum; **pt** platform-like nymph; **RV** right valve; **t1–t2** hinge teeth of right valve; **t3–t5** hinge teeth of left valve; **um** umbo.

#### **DISCUSSION**

The absence of *Gari* species on the Western Atlantic coast (Warmke & Abbott, 1962; Abbott, 1974; Rios, 1994) was a surprising phenomenon in view of the presence of several species on the West Coast of the Americas and on the Europe-Africa coast. The present discovery in part fills this apparent gap. No fossil *Gari* species have been discovered in Brazilian formations (Simone & Mezzalira, 1994), however, three species from the Tertiary of Patagonia is the closest known occurrence (Ihering, 1907).

Gari linhares cannot be confused with any Brazilian species of related bivalves, nor with the remainder of Atlantic species. From them, apparently the closest species is the Mediterranean/West African G. depressa (Pennant, 1777) (Nicklès, 1950: 216; Cosel, 1989: 703; Poppe & Goto, 1993: 114), from which, G. linhares differs in being more compressed laterally, poorly coloured and by having a smaller anterior region. G. linhares also differs from G. castrensis (Spengler, 1794) (cf. Cosel, 1989) in having larger dorso-ventral distance and absence of colour; from G. tellinella (Lamarck, 1819) (cf. Cosel, 1989) in being longer dorso-ventrally; and from G. gofasi Cosel, 1989 by its more central umbo and shorter outline. From the remainder Atlantic Gari species, G. linhares differs in lacking a developed sculpture. From the species of the Pacific Coast of the Americas, G. linares cannot be confused with any other. It differs from G. fuscata (Hinds, 1844), G. helenae Olsson, 1961 and G. panamensis Olsson, 1961 by having not such a long outline; from G. lata (Deshayes, 1855) and G. maxima (Deshayes, 1855) by a longer antero-posterior outline; from G. regularis (Carpenter, 1864) by narrower posterior margin, lack of posterior carina and by the striae in posterior slope. However, G. regularis appears to be the most similar West Pacific Gobraeus species.

#### **ACKNOWLEDGEMENTS**

Thanks to the collector of the specimens, Bernardo Linhares de Albuquerque from Bahia and to the anonymous referee for the valuable comments on the paper.

#### REFERENCES

- Abbott R.T. 1974 American Seashells (2nd edition) Van Nostrand Reinhold Company, New York 663 pp. + 24 pls.
- Cosel R. von 1989 Taxonomy of tropical West African bivalves II. Psammobiidae Bulletin du Muséum National d'Histoire Naturelle section A ser. 4 11 (4): 693–731.
- IHERING H. von 1907 Les Mollusques fossiles du Tertiaire et du Crétacé Supérieur de l'Argentine *Anales del Museu Argentino de Ciencias Naturales B. Rivadavia* ser. 3 **14** (3): 1–611 + 18 pls.
- Keen A.M. 1971 Sea Shells of Tropical West America (2nd edition) Stanford University press, California xiv + 1064 pp.
- Moore R.C. 1969 Mollusca 6: Bivalvia. Treatise on Invertebrate Paleontology University of Kansas N6 (2): 491–952.
- NICKLÈS M. 1950 Mollusques testacés marins de la côte occidentele d'Afrique P. Lechevalier (ed) Paris, 269 pp.
- POPPE G.T. & GOTO Y. 1993 European Seashells Verlag Christa Hemmen. Wiesbaden 2: 1–221.
- Rios E.C. 1994 Seashells of Brazil (2nd edition) Editora da FURG Rio Grande 368 pp. + 113 pls.
- SIMONE L.R.L. & MEZZALIRA S. 1994 Fossil Molluscs of Brazil Boletim do Instituto Geologico 11: 1–202.
- WARMKE G.L. & ABBOTT R.T. 1962 Caribbean Seashells Dover Publications, Inc. New York 348 pp.
- Willan R.C. 1993 Taxonomic revision of the family Psammobiidae (Bivalvia: Tellinoidea) in the Australian and New Zealand region *Records of the Australian Museum* suppl. **18**: 1–132.

## A RECORD OF FERRISSIA (PETTANCYLUS) CLESSINIANA (JICKELI) IN SWEDEN, WITH REMARKS ON THE IDENTITY AND DISTRIBUTION OF THE EUROPEAN FERRISSIA SPECIES.

In the collection of the Swedish National Museum of Natural History in Stockholm, Sweden we recently detected a sample labelled *Ferrissia* sp. It consisted of a single specimen, collected in the large bassin in the *Victoria regia*-house in the Bergianska Botanical Garden, Stockholm (leg. L. Söderberg, August 1943). The specimen belongs to a, today in Europe, wide-spread species, which we consider identical with *Ferrissia (Pettancylus) clessiniana* (Jickeli 1882). Although never refound, this shows that the species has at least temporarily been present in Sweden.

In the extensive existing literature on this snail it is almost exclusively referred to as *Ferrissia wautieri* (Mirolli 1960). Attention was first drawn to this form in the 1940's, when it was found in S. France (Roger J. & Calas P.¹). Several opinions have existed concerning the identity and origin of this puzzling species which, in 1960, was described under a new name – *Watsonula wautieri* (Mirolli M.²). There exist different theories, whether it is an indigenous and overlooked form or a rather recent introduction in Europe; cf. discussion in Schmid G.³, Wautier J.⁴, Kinzelbach R.K.⁵ and further references given in these papers.

Concerning the identity of the species we would like to draw attention to the fact that already in 1970 (Hubendick B.6) *F. wautieri* was placed in the synonymy of *Ferrissia clessiniana* (Jickeli 1882). This, in our opinion, correct procedure seems, however, to have been overlooked or neglected by most later authors. Hubendick<sup>7</sup> also gives strong evidence that the Palearctic forms of *Ferrissia* should be placed in the subgenus *Pettancylus* Irredale 1943 (of which *Watsonula* Mirolli 1960 is a younger synonym).

The name *F. clessiniana* was first used for the species living in the Near East (Israel) by H.K. Mienis<sup>8</sup>, and in the checklist of the freshwater mollusca of Israel<sup>9</sup>, he confirms the

synonymization by Hubendick (1970).

The conspecificity of the N. African and European forms strengthens the theory that at least the S. European occurrences are autochtonous and probably form part of a Mediterranean-Near East distribution area. Several records exist from the Near East-region (Kinzelbach R.K.¹º). Kinzelbach (1984) hints on the possiblity that the European and N. African forms might belong to the same species, which he calls *F. wautieri*. This name is also applied to material from Syria (Schütt H.¹¹).

Kinzelbach mentions the possibility of a conspecificity also with *Ferrissia isseli* (Bourguignat 1866 (wrongly cited as 1853!)). At the present state of knowledge, however, we see no reason for this. The forms are treated as separate species (form groups) by Hubendick (1970) and this point of view is held also by Mienis (1983) and Brown D.S.<sup>12</sup>.

Still another point of view is to be found in the Ukrainean freshwater mollusc fauna (Stadnichenko A.P.¹³), which synonymizes the European form with *Pettancylus australicus* (Tate 1880) - a procedure which hardly can be accepted. According to the strong evidence given by Hubendick¹⁴ *P. australicus* belongs to the form group of *Ferrissia* (*Pettancylus*) *pettardi* (Johnston 1879), which is geographically restricted to the Australian region.

North of the Mediterranean region, *F. clessiniana*, in the present period of Holocene, is most probably a rather recent newcomer. In the latest decades it has expanded rapidly into new areas of Western, Central and Eastern Europe, an expansion process which still continues. It seems highly probable that this process has been facilitated by human

activities.

- <sup>1</sup>Roger J. & Calas P. 1944 Bull. mens. Soc. linn. Lyon 13: 31–32.
- <sup>2</sup>MIROLLI M. 1960 Mem. Ist. ital. Idrobiol. **12**: 121–162.
- <sup>3</sup> SCHMID G. 1975 Arch. Moll. 106: 15–24.
- <sup>4</sup> Wautier J. 1977 *Malacologia* **16**: 285–289.
- <sup>5</sup>KINZELBACH R.K. 1984 Hess. faun. Briefe 4: 20–24.
- <sup>6</sup> Hubendick B. 1970 Acta r. Soc. Sci. Litt. goth. Zool. 5: 1–52.
- <sup>7</sup> Hubendick B. 1964 Göteb. k. Vet.- Vitterh.-Samh. Handl. 9B: 1–72.
- <sup>8</sup> Mienis H.K. 1977 Levantina 8: 81–82.
- <sup>9</sup>MIENIS H.K. 1983 Levantina 47: 543–550.
- <sup>10</sup> KINZELBACH R.K. 1985 Hess. faun. Briefe 5: 32–36.
- <sup>11</sup> SCHÜTT H. 1983 Arch. Moll. 113: 17-91, 225-228.
- <sup>12</sup> Brown D.S. 1994 Freshwater Snails of Africa Taylor & Francis, London 608 pp.
- <sup>13</sup> Stadnichenko A.P. 1990 Fauna Ukraini 29 (4) Kiew (Naukowa Dumka) 291 pp.
- <sup>14</sup> Hubendick B. 1967 Acta r. Soc. Sci. Litt. goth. Zool. 1: 1–52.

Gerhard Falkner
Bayerische Staatssammlung für
Paläontologie und historische Geologie
Richard-Wagner-Straße 10/II
D-80333 München
Germany

Ted von Proschwitz Dept. of Invertebrate Zoology Natural History Museum Box 7283 S-40235 Göteborg Sweden

### EUCONULUS ALDERI (J.E. GRAY) ON THE IBERIAN PENINSULA.

The distribution of *Euconulus alderi* (J.E. Gray) in Europe must still be considered as poorly known. This is partly a consequence of, that the status of this form - as a separate species, distinct from the common and wide-spread *Euconulus fulvus* (O.F. Müller) - has not been recognized, or is questioned, even in the major manuals on land Mollusca (cf. Kerney M.P. *et al.*¹). *E. alderi* is, however, without doubt a distinct species, defined as well by its morphological characters as by its habitat selection (cf. von Proschwitz T.²).

In recent papers, dealing with the genus *Euconulus* on the Iberian peninsula (Altonaga K.³; Altonaga K. et al.⁴) only one species - E. fulvus - is recognized.

During a collecting trip in N. Spain in 1995, however, we found *E. alderi* in two sites: Prov. Lugo, at the left bank of Río Eo, near Ría de Abres 31-08-1995 (2 specimens). Habitat: Sedge marsh;

Prov. Léon, at Río Esla, between Villamáñán and Valencia de Don Juan 10-09-1995 (3 specimens). Habitat: Water-fringe vegetation of reed.

Morphologically the specimens are of the same type as specimens of *E. alderi* from France and Middle Europe. Also the habitats are similar to such in which the species lives in other parts of Europe.

As *E. alderi* has been recorded in N. Africa (Morocco, Algeria; Seddon M.B. & Holyoak D.T.<sup>5</sup>), it seems probable, that *E. alderi* might have occurrences in suitable wetland habitats throughout the Iberian peninsula. Further fieldwork and critical revisions of museum material of the genus *Euconulus* might reveal that this neglected species is widely distibuted in the Mediterranean area.

<sup>&</sup>lt;sup>1</sup>Kerney M.P., Cameron R.A.D. & Jungbluth J.H. 1979 Die Landschnecken Nord- und Mitteleuropas. Paul Parey, Hamburg/Berlin 384 pp.

- <sup>2</sup>Proschwitz T. von 1985 Malak. Abh. staatl. Mus. Tierk. Dresden 10: 95–108.
- <sup>3</sup> Altonaga K. 1990 Cuadernos de Investigación biológica (Bilbao) 16: 1–21.
- <sup>4</sup> Altonaga K., Prieto C.E. & Ruiz de la Rosa J.M. 1988 *Iberus* 8 (2): 47–52.

Gerhard Falkner
Bayerische Staatssammlung für
Paläontologie und historische Geologie
Richard-Wagner-Straße 10/II
D-80333 München
Germany

Ted von Proschwitz Dept. of Invertebrate Zoology Natural History Museum Box 7283 S-40235 Göteborg Sweden

## A FURTHER RECORD FOR *PALUDINELLA LITTORINA* (DELLE CHIAJE, 1828) ON THE SOUTH COAST OF ENGLAND

The marine prosobranch *Paludinella littorina* (delle Chiaje, 1828) lives in interstitial, rock and crevice habitats on the upper shore. The species has a south-west distribution in the British Isles and its small size and cryptic habitat results in it rarely being recorded living. Until 1991, *P. littorina* was known living only from a single site in the British Isles in the Fleet<sup>1</sup>. Since then, using a greater understanding of the species' ecology, it has been recorded at sites on the Isle of Wight, north Devon<sup>2</sup> and Pembrokeshire<sup>3</sup>. Although the snail is uncommon, it is almost certainly under-recorded. A more detailed review of the taxonomy, ecology and distribution of *P. littorina* is in preparation.

A population of *P. littorina* was discovered in an upper shore cave in the Chalk cliffs at Beer, Devon (50°41.6′N 03°05.6′W) on 17.ix.1997. It was associated with *Otina ovata* Brown, 1827, as it is at the north Devon and Pembrokeshire sites. This is the first living record from south Devon. Marshall<sup>4</sup> found dead shells at Torbay and Dartmouth (specimens in National Museum of Wales) suggesting that it may still occur at other sites in

the area.

Members are encouraged to search potentially suitable cave habitats in south-west England and Pembrokeshire, but should be aware that *P. littorina* is protected under the Wildlife & Countryside Act 1981, Schedule 5, making it illegal to collect, injure or kill without a licence from the conservation agencies. Advice should be sought from the Marine Recorder if new populations are discovered.

Janice M. Light 88 Peperharow Road Godalming Surrey GU7 2PN U.K. Ian J. Killeen Malacological Services 163 High Road West Felixstowe IP11 9BD U.K.

<sup>&</sup>lt;sup>5</sup>SEDDON M.B. & HOLYOAK D.T. 1993 J. Conch. **34**: 321–331.

<sup>&</sup>lt;sup>1</sup> LIGHT J.M. 1986 J. Conch. **32**: 260.

<sup>&</sup>lt;sup>2</sup> Light J.M. 1991 Conchologists' Newsletter 119: 433–434.

<sup>&</sup>lt;sup>3</sup> KILLEEN I.J. & LIGHT J.M. 1994 CCW Science Report 62. CCW.

<sup>&</sup>lt;sup>4</sup> Marshall J.T. 1913 J. Conch. **14**: 65–77.

#### **REVIEW**

Coral Reef Animals of the Indo-Pacific T.M. Gosliner, D.W. Behrens & G.C. Williams 1996 Sea Challengers, Monterey, California pp. 314, \$45 (£30).

The impact of the front cover of this attractive book is good - lots of invertebrates (a nice change from fish and sharks) in an artistic arrangement: anemone, soft coral, cowrie, stomatopod, ascidians, brittle star, and flatworm. Inside, the title page says: Coral Reef Animals of the Indo-Pacific: animal life from Africa to Hawai'i exclusive of the vertebrates. ...

The text and bullet points on the back cover advertise its usefulness to divers and that the work of the 50 best photographers has been used. It then goes onto the more important aspects, such as species coverage (more than 1100) and the geographical area

included. Marketing ploys, but never-the-less ....

The book itself is almost A4 in page size, 1+ cm thick, softback; substantial, heavy, and lovely to handle. A foreword by John Randall is followed by a 13-page introduction, covering classification, evolution, phylogeny, biotic communities, corals and coral reefs, and biogeography. This is all very readable, informative, and nicely illustrated. A page is devoted to 'how to use this book': in this the authors absolve themselves of their title and state that they cover 'the tip of the iceberg'. Then the photographic section begins, phylum by phylum, followed by the final pages of acknowledgements, references, list of genera, and index.

The colour photos are without doubt beautiful, and it appears it was this which governed the inclusion of species - with tens of 1000s of named species, previously never or badly illustrated, the inclusion of named species rather than unnamed ones would have been more beneficial: approximately only half of each group has named species, except for the molluscs. The range of coverage devoted to this latter phylum is extensive, including many unusual species. The photographs are of live animals in their natural habitat, which is a bonus for shells are normally pictured dead. Some lovely cephalopods are included, as well as tusk shells and polyplacophorans. Many other interesting groups are covered: the benthic ctenophores are great - I wonder if I have ever seen one but not known? - and there are some lovely pycnogonids and flatworms.

One big problem I have with this book, and really the main criticism, is that there are no scales or indications of size. This really is a bind, and a major oversight on the part of the authors and the publishers. Otherwise, in the text accompanying the photographs, there is good information on natural history, including the locality of the specimen photographed. There are numerous range extensions, and new records; some species are recorded for the first time since their original descriptions. The information included for each species is without doubt useful, even if you haven't a name for the beast!

Dr Nathalie Yonow Marine Biologist Swansea University Swansea U.K.

#### **INSTRUCTIONS TO AUTHORS**

Manuscripts should be sent to:

THE HON. EDITOR, DR P.G. OLIVER,
NATIONAL MUSEUMS & GALLERIES OF WALES, CATHAYS PARK, CARDIFF CF1 3NP.
GRAHAM.OLIVER@NMGW.AC.UK

Papers Two copies of text and illustrations should be submitted; one set of illustrations must be good quality originals. Authors should refer to *New Instructions to Authors* in Volume 36, No. 1 as a guide to format. Authors are reminded of the high cost of printing and therefore are expected to write concisely and to make maximum use of page size when designing artwork and tables.

COMMUNICATIONS These are intended to be short notes of an original nature which do not merit the treatment of a full paper. *Communications* do not normally contain any figures, tables or plates and should conform in style to that of recent issues of the *Journal*.

### Journal of Conchology

Vol. 36, No. 3, September 1998

Contents	DAC
	PAG
PAPERS	
GIUSTI F., MANGANELLI G. & BODON M. A proposed neotype for <i>Hydrobia acuta</i> (Draparnaud, 1805).  BRINER T. & FRANK T. Egg laying activity of the slug <i>Arion lusitanicus</i> Mabille	1
in Switzerland.  GERLACH J.	9
A new genus of Zonitoidea previously referred to Kaliella.  A new species of Punctidae (Mollusca: Gastropoda) from Seychelles.  COLVILLE B. & RIEDEL A. On the systematic position of Araboxychilus sabeus (Gastropoda: Pulmonata) from the south-west of the Arabian Peninsula.  SIMONE L.R.L. A new species of Gari (Gobraeus) (Bivalvia, Tellinoidea, Psammobiidae) from Bahia coast, Brazil.	17 23 27 35
Communications	
Falkner G. & von Proschwitz T.  A record of <i>Ferrissia (Pettancylus) clessiniana</i> (Jickeli) in Sweden, with remarks on the identity and distribution of the European <i>Ferrissia</i> species. <i>Euconulus alderi</i> (J.E. Gray) on the Iberian Peninsula.  Light J.M. & Killen I.J. A further record for <i>Paludinella littorina</i> (Delle Chiaje, 1828) on the south coast of England.	39 40 41
Review	43

# Journal of Conchology

(Established 1874)

Vol. 36, Part 4, November 1998

onchological Society of

Great Britain and Ireland

#### CONCHOLOGICAL SOCIETY OF GREAT BRITAIN AND **IRELAND**

Registered Charity No. 208205

SMITHSONIAN MAR 3 1 1999 LIBRARIES 21c L HDN. SECRETARY Ms. J. Reynolds, 21c Loraine Road, Holloway, London N7 6EZ

HON. TREASURER Ms. A.J. Trew, National Museums & Galleries of Wales, Cathays Park, Cardiff CF1 3NP

HON. MEMBERSHIP SECRETARY M.D. Weideli, 35 Bartlemy Road, Newbury, Berks. RG14 6LD

HON. EDITOR Dr P.G. Oliver, National Museums & Galleries of Wales, Cathays Park, Cardiff CF1 3NP

HON. CONSERVATION OFFICER Dr M.J. Willing, 14 Goodwood Close, Midhurst, Sussex GU29 9JG

HON. MARINE CENSUS RECORDER Mrs J. Light, 88 Peperharow Road, Godalming, Guildford, Surrey GU7 2PN

HON. NON-MARINE CENSUS RECORDER Dr M.P. Kerney, Department of Zoology, Natural History Museum, Cromwell Road, London SW7 5BD

HON. NEWSLETTER EDITOR Miss R.E. Hill, 447B Wokingham Road, Earley, Reading RG6 7EL

Member's subscription £23 per annum. Entrance fee £1.

Family membership £25 per annum.

Institutional membership £32 (UK rate); £37 (overseas\*) per annum.

Student membership £10 per annum.

\*Overseas members are reminded that all fees due to the Society are payable in pounds sterling.

Publications Members receive:

The Journal of Conchology (usually two numbers a year)

The Conchologists' Newsletter (quarterly)

For back-numbers of these publications and special numbers please apply to: Mr M.D. Weideli, 35 Bartlemy Road, Newbury, Berks. RG14 6LD.

There are six indoor meetings per year between October and May, usually held at the Natural History Museum. Field meetings, workshops and other events are held throughout the year at various locations.

> © Conchological Society of Great Britain and Ireland Printed by Henry Ling, The Dorset Press, Dorchester DT1 1HD

# A CONTRIBUTION TO THE KNOWLEDGE OF THE GENITAL ANATOMY OF *ZINGIS* SPECIES WITH PARTICULAR ATTENTION TO *ZINGIS DEPRESSA* (GERMAIN) (PULMONATA: UROCYCLIDAE)

#### B. Verdcourt<sup>1</sup>

Abstract Salient features of the anatomy of Zingis depressa are described, the animal being previously totally unknown. Although its correct position will not be entirely clear until the type species of Zingis is dissected, its relationships with allied species are discussed and four subgenera are described.

Key words Zingis, Urocyclidae, Gastropoda, Pulmonata, Anatomy, Tanzania.

#### Introduction

In 1916, Germain described a variety depressa from Kipatimu in Tanzania of the Ethiopian species Trochonanina germaini C.R. Boettger. The ecology of the Harrer uplands (the type locality of the latter) is so diverse from the lowlands of Tanzania that it seemed very unlikely the two taxa were closely related. This doubt was heightened when I first examined Germain's type in the 1950s in Paris. Many years later I borrowed a syntype for a more detailed examination and gave some account of it and its allies (Verdcourt, 1990) and suggested it should be treated as a species of Zingis. Trochonanina germaini appears never to have been recollected but it is adequately figured by its author (Boettger, 1913) and I am certain it is not closely related to Zingis depressa. It was, therefore of great interest to find three specimens of the latter with the animals preserved in a collection made by Frontier Tanzania and passed to me by Julian Bayliss. They had been collected in Morogoro Region, Kilombero District, Uzungwa Mts., Udungwe Swamp Forest Reserve, 3 miles N. of Chira in a marginal area between evergreen forest and cultivated land at about 300 m. It is I think the first material of the animal to have been collected. The material has been placed in the Natural History Museum; two of the three specimens I have left untouched for future use by hands more competent than mine.

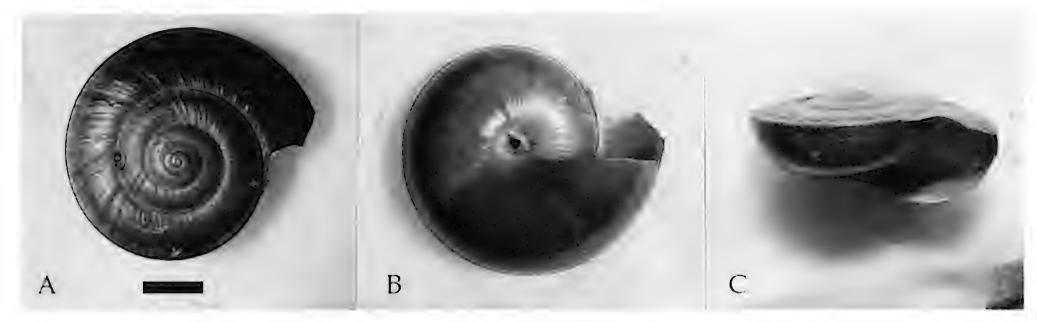
#### Abbreviations used in anatomical drawings

a-atrium
ag-albumen gland
bw-body wall
c-caecum 1 (upper caecum, upper flagellum)
cd-common duct
da-diverticule of atrium
ep-epiphallus
epe-everted penis
er-epiphallial retractor
f-flagellum (caecum 2)
hd-hermaphrodite duct

hg-hermaphrodite gland

or-ocular retractor
ov-oviduct
p-penis
pp-penial papilla
pr-penial retractor
ps-penial sheath
s-spermatheca
sd-spermathecal duct
sp-spermatophore
ta-'tige axiale', thickened ridge of flagellum
ut-uterus
v-vagina
vd-vas deferens

<sup>&</sup>lt;sup>1</sup> Royal Botanic Gardens, Kew, Richmond, Surrey, TW9 3AB.



**Fig. 1** Zingis (Tropidocochlion) depressa (Germain). **A–C** Top, bottom and side views of syntype Scale bar = 1 cm.

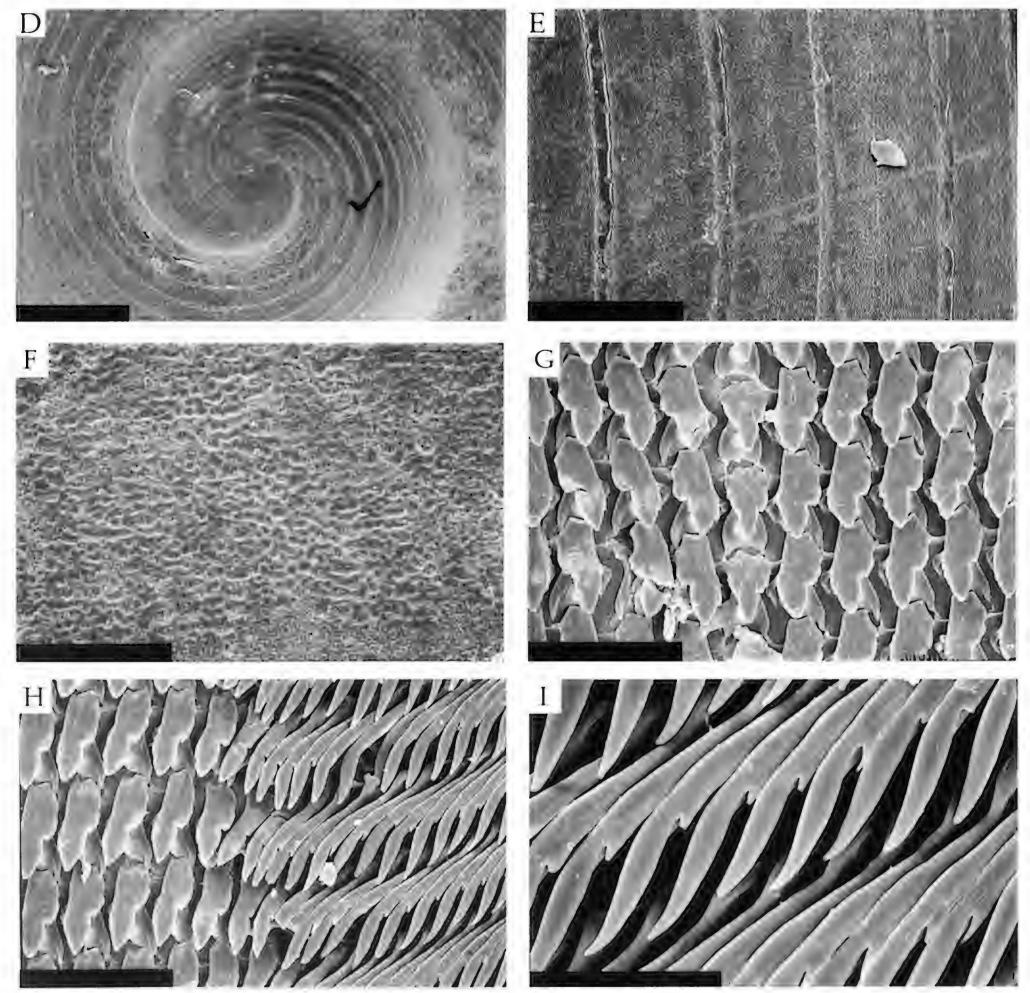
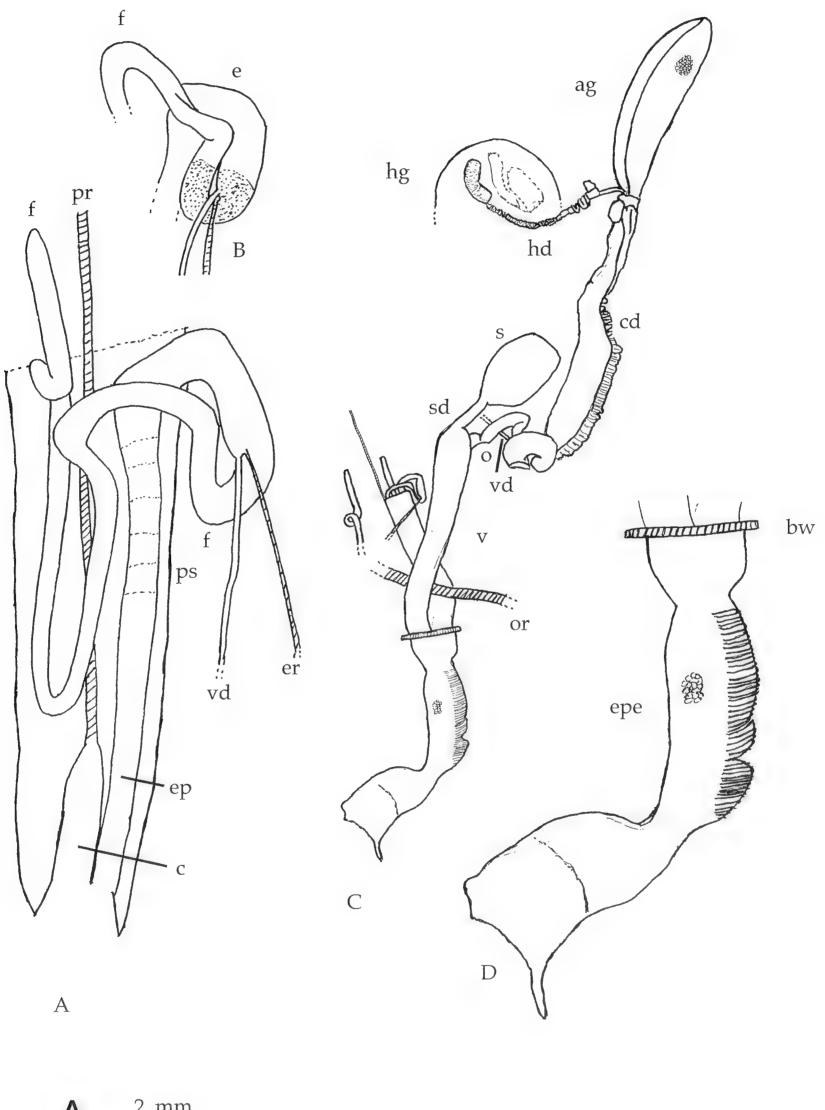


Fig. 2 Zingis (Tropidocochlion) depressa (Germain). A–F SEMs from specimen collected in Tanzania, Uzungwa Mts. by Frontier Tanzania A Microspiral sculpture of protoconch. B Ditto at higher magnification. C Sculpture between spirals. D Radula, central tooth and first 4–5 laterals. E Last 5 laterals and first 14 marginals. F Marginals 7–15. Scale bars  $A=50~\mu m$ ;  $B=100~\mu m$ ;  $C=20~\mu m$ ;  $D=100~\mu m$ ;  $E=100~\mu m$ ; E=10

#### **DESCRIPTION**

The shell measures 27 x 22 x 13 mm and is very strongly keeled; body whorl chestnut above with the rest paler brown and glossy; base of shell chestnut. The protoconch has 11 fine spiral grooves with the surface between exceedingly finely pitted-reticulate, the sculpture being clearly visible at about x 1000; the rest of the shell above is transversely ribbed (Fig. 1A–C, Fig. 2A–C). Animal outstretched in spirit, 3–4 cm long, the caudal tail slender, 6 mm long but apparently missing in one specimen; foot 5–6 mm wide, clearly



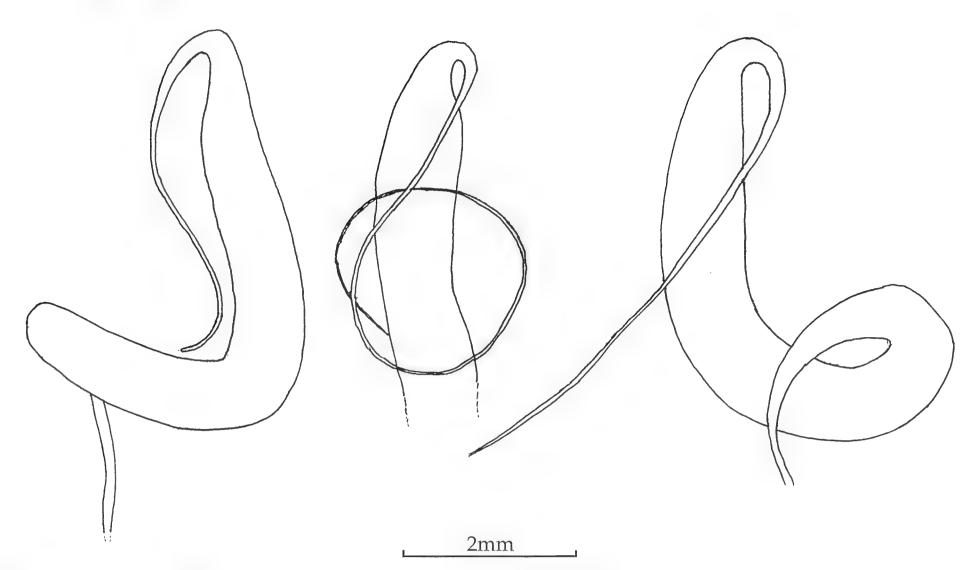
A 2 mm

C 1 cm

D 5 mm

Fig. 3 Zingis (Tropidocochlion) depressa (Germain), Tanzania, Uzungwa Mts., leg. Frontier Tanzania, genital anatomy.

#### 4 B. VERDCOURT



**Fig. 4** Zingis (Tropidocochlion) depressa (Germain), spermatophores, Tanzania, Uzungwa Mts., leg. Frontier Tanzania.

divided into three areas, the outer slightly darker. The mantle edge is very complicated; the outer right edge is undulate and the right hand inner flap relatively very large; the left hand flap is also large and there is a spathulate median flap.

The jaw is of typical zonitid shape, 3.4 mm broad, 0.8 mm wide at the sides and 1.1 mm wide across the median line to the apex of the projection. The radula is about 6 mm long, 2.9-3.4 mm wide, with about 115 rows with the formula  $\pm 70$ : 16: C :16:  $\pm 70$ . The marginal teeth are very characteristic, with a very slender hook-like ectocone at the base of the main cusp, quite dissimilar from the bifid apex found in many Urocyclidae (Fig. 2D–F) .

The genitalia in the specimen dissected were everted and the internal surface of the penis is conspicuously tessellated. The general disposition of the organs is as in most Urocyclidae (Fig. 3) but there are features which I have not seen correlated in other species. The main penial retractor muscle is attached to a short caecum which directly terminates the penis and the epiphallus originating beside it at the same level is a long tube crooked at the apex. There is a small thickening at the point of origin of the vas deferens but the epiphallus continues as a long caecum (flagellum). There is a slender muscle below the point of origin of the vas deferens possibly to assist the main retractor muscle in getting the complex back into position. I do not recall seeing this in other Urocyclidae although muscles attached to dart sacs and similar appendages are common. The female and common ducts are without marked differences from the usual pattern. The spermatheca contained three spermatophores, two being more or less intact, sausage-shaped, unsculptured and strongly attenuated at both ends (Fig. 4). The shape is likely to be of taxonomic significance but unfortunately is unknown for a large number of species.

#### RELATIONSHIPS WITH OTHER SPECIES

The problem of *Zingis* has been mentioned many times (Verdcourt, 1961, 1991; Watson, 1934) and the referral of *Zingis depressa* and its obvious allies to this genus is little more

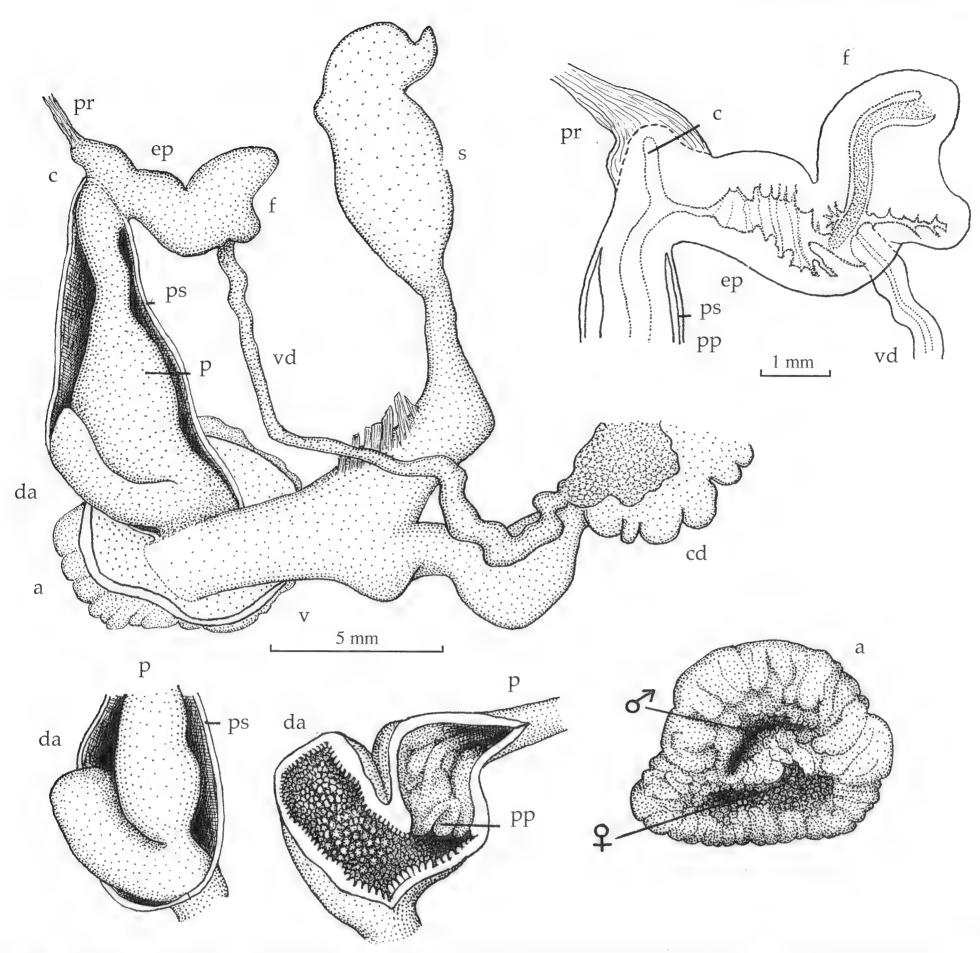


Fig. 5 Zingis (Chirinda) chirindensis van Bruggen & Verdcourt, Zimbabwe, genital anatomy (after Van Mol).

than guesswork until the basic facts of the anatomy of the type are known. It is true that when von Martens (1878) first described the genus he gave some account of Pfeffer's meagre description of the anatomy and some drawings but the information is of little value. The following is a very free translation 'Herr Dr Pfeffer has closely examined the dried-up animal and ascertained the following characteristics; the mantle edge has two neck lobes but no shell lobe; there is a distinct caudal pore at the end of the foot overlapped by a horn-shaped appendage; sole undivided; jaw small with central projection; radula of the Nanina-type, the central tooth with two side cusps and a lanceolate central cusp, 11 laterals on each side with very feeble low inner cusps and strong outer cusps; marginal teeth 110 on both sides, unequally two-cusped; teeth in 122 rows; a male appendicular gland and probably a flagellum; no female appendicular gland, only a long appendix on the stalked vesicle which as in Thapsia is inserted high above the vagina; spermatophore with very numerous small regular elliptic calcareous granules; this snail most certainly belongs in the 'Vitriniden' near Zonites and Nanina'. Apart from the radula one learns little about the actual disposition of the organs and the figure is very poor; one must remember, however, that the material was in a poor state. One fact emerges - the marginals have pincer-like cusps as in many Trochonanina species but the

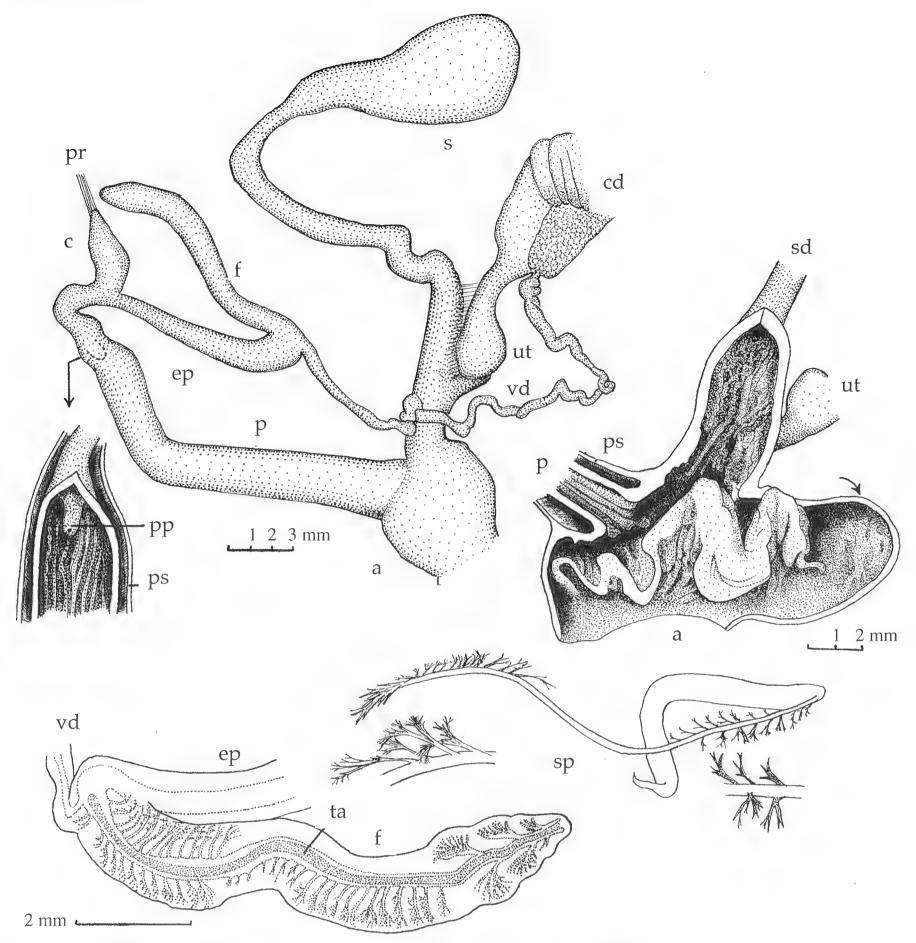


Fig. 6 Zingis (Morrumbalia) morrumbalensis (Melvill & Ponsonby), Zimbabwe, Vumba, genital anatomy (after Van Mol)

shell does not agree with that genus. Watson (1934) commented rather scathingly on the account and doubted even the statements about the undivided foot-sole and absence of shell lobes.

Van Mol (1970) has dealt with the *Helicarion*-like members of the Urocyclinae in detail and pointed out how the Gymnarioninae, which lack all caeca on the epiphallus and penis-apex form a quite different group. Only the slug *Phaneroporus* appeared from its description to be similar. Van Goethem (1977b) has exhaustively revised the slug-like species - *Urocyclini* - and has pointed out that Simroth's original description of *Phaneroporus* being without an epiphallus or a caecum (kalkesache) would remove it from the urocyclid slugs altogether. He believes that Simroth's figure was drawn from immature material and that the second species referred to the genus was actually based on an immature specimen of *Trichotoxon heynemanni* Simroth. A slug with more conventional anatomy has been identified as adult *Phaneroporus* thus resolving the anomaly. Within the slug-like Urocyclidae there are two lines which Van Goethem considers fundamentally separate - the species with a distinctly developed long flagellum and those in which this is replaced by a small nodular white bursa calcifera (kalksache). The term lime-gland is confusing since it has been used for the upper caecum.

Less has been written about the other groups of Urocyclidae containing the genera Trochonanina, Trochozonites, Zingis, Sheldonia, Thapsia etc. although Pilsbry (1919), Verdcourt (1961, 1982, 1984, 1986, 1992), Watson (1925), Lopez (1951) and others have investigated a number of species. About 20 years ago J.-J. Van Mol (Université Libre de Bruxelles) gave me a copy of parts of a lengthy manuscript of a revision of much of this group; unfortunately this has never been published. He has recently sent me some of the drawings which were made to accompany it which has allowed me to compare the anatomy of Z. depressa with that of its probable allies i.e. five species which have been placed in the same genus; to the three already known anatomically Van Mol has added many details. The manuscript contains very detailed descriptions of the shell and anatomy, too lengthy to reproduce here with the exception of the more important drawings. One of the five species was one which he intended to describe as new but unfortunately the material on which it was based has been mislaid. Despite the existence of a complete account of the shell and anatomy it seemed unwise to formally name it when no actual material is known to be extant. Lopez (1951) examined several species of Trochozonites and found that the penial retractor is attached to the end of the upper caecum in T. ibuensis, T. lindstromi, T. folini, T. hystrix, T. suturalis, T. bifilaris (which he dubiously refers to Sitala and his description of the radula suggests this is its affinity), T. multisulcatus, T. hintzi, T. pooensis and T. nostii and that in the first two mentioned a small stimulating organ is present. In most there is a flagellum at the junction of the epiphallus and the vas deferens but in T. folini, T. hintzi and T. pooensis there is a bursa calcifera and in ?T. bifilaris and T. multisulcatus there is neither. In T. usambarensis I (Verdcourt, 1982) found the penial retractor attached to the apex of the penis at the junction of the epiphallus and there is a bursa calcifera instead of a flagellum. T. (Zonitotrochus) medjensis on the other hand has both an upper caecum and a flagellum, the penial retractor attached to the epiphallus some distance from the apex of the penis and at the base of the upper caecum, and a very characteristic spermatophore (Verdcourt, 1984). Pilsbry (1919, 251) divided Trochozonites into three subgenera and it is clear that a number of distinct genera are included in Trochozonites. Pilsbry's subgenera were based on distinct differences in the sculpture of the protoconch but I have only dissected the type of subgenus Zonitotrochus. In typical Trochonanina there is a penial gland and a small white bursa calcifera. If my erection of the subgenus Montanobloyetia (Verdcourt, 1961) of Trochonanina on purely intuitive grounds is valid then it follows that the position of the penial retractor at the base or apex of the upper caecum is not such an important character since in T. (M.) simulans from Kilimanjaro and Meru it is at the base whereas in T. (M.) keniana from Mt. Kenya it is at the apex.

In *Thapsia grandis* (Verdcourt, 1982) the penial retractor is attached to the apex of the penis at the base of the upper caecum and there is neither a lower flagellum nor bursa calcifera but Watson (1934: 185) states that the penial retractor is attached to the 'apex of the epiphallic caecum' in *T. oscitans* and *T. troglodytes*. In this genus there are numerous species with very similar shells and it will be of great interest to discover the range of

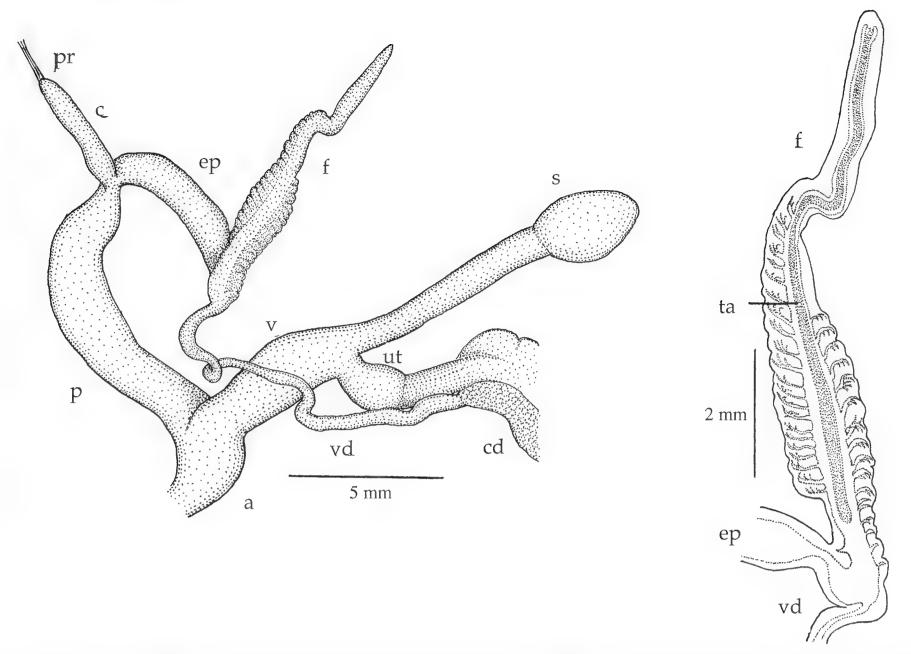
The South African genus *Sheldonia* has a well developed flagellum, penial retractor attached to the epiphallus between the base of the upper caecum and the entrance of the epiphallus into the penis, spermatophore with branched spines and marginal teeth of the radula either bicusped or with the ectocone reduced or even absent; apical whorls of shell very finely spirally striate.

It is clear that much the same anatomical patterns reappear in snails referred to different genera and it is not possible to make identifications from the anatomy alone; characteristic and the shall be added to be a label of the shall be added to be a label of the shall be added to be a label of the shall be added to be a label of the shall be added to be a label of the same anatomical patterns reappear in snails referred to different entry and the shall be added to be a label of the same anatomical patterns reappear in snails referred to different entry and the same anatomical patterns reappear in snails referred to different entry and the same anatomical patterns reappear in snails referred to different entry and the same anatomical patterns reappear in snails referred to different entry and the same anatomical patterns reappear in snails referred to different entry and the same anatomical patterns reappear in snails referred to different entry and the same anatomical patterns reappear in snails referred to different entry and the same anatomical patterns reappear in snails referred to different entry and the same anatomical patterns reappear in snails referred to different entry and the same anatomical patterns reappear in snails referred to different entry and the same anatomical patterns reappear in snails referred to different entry and the same anatomical patterns reappear in snails referred to different entry and the same anatomical patterns reappear in snails referred to different entry and the same anatomical patterns reappear in snails referred to different entry and the same anatomical patterns reappear in snails referred to different entry and the same anatomical patterns reappear in snails referred to different entry and the same anatomical patterns reappear in snails referred to different entry and the same anatomical patterns reappear in snails and the same anatomical patterns reappear in snails and the same anatomical patterns reappear in snails and the same anatomical patterns reappear in snai

acters of the shell have to be taken into account.

anatomical variation.

The closest relatives of *Zingis depressa* are *Z. chirindensis*, *Z. morrumbalensis*, *Z. sesquicincta*, *Z. brunneofasciata* and an undescribed species; there are several others prob-



**Fig. 7** Zingis (Morrumbalia) brunneofasciata Verdcourt, Mozambique, genital anatomy (after Van Mol).

ably related but their anatomy is unknown. *Z. depressa* differs from all these in its long slender flagellum and strongly keeled shell; it shares the lack of a penial gland or other penial appendage and possession of an upper caecum with all but *T. chirindensis*; the marginal radular teeth resemble only those of *Z. sesquicincta*.

Carinazingis van Bruggen and de Winter (1990) has characters not shared by any of the species considered here, a frontal organ similar to that in *Gymnarion* Pilsbry, a penial retractor which is branched and attached to both caecum and flagellum and marginal teeth of the radula with several accessory cusps apart from the apical ectocone forming a 'pincer' with the main cusp; the complicated spermatophore resembles that of *Zingis morrumbalensis*.

In order that progress is not lost sight of I have proposed four new subgenera despite the fact that the anatomy of the type of *Zingis* is not yet adequately known. From the shells alone I am convinced that it is not identical with any of these described below. By utilising subgenera future nomenclatural alterations are reduced to a minimum.

Zingis (Zingis) von Martens (1878) Type species Zingis radiolata von Martens

*Zingis radiolata* von Martens, 1878: 290, t.1, Figs 8–17. *Peltatus polystephes* Tomlin, 1915: 319, Fig.

Shell helicoid with characteristic variable colouring including chalky banding, the protoconch with excessively fine microspiral striae, almost obsolete and obscured by faint transverse sculpture; body whorl not keeled. Original description of genital anatomy inadequate. Marginal teeth of radulae with cusps apical, pincer-like.

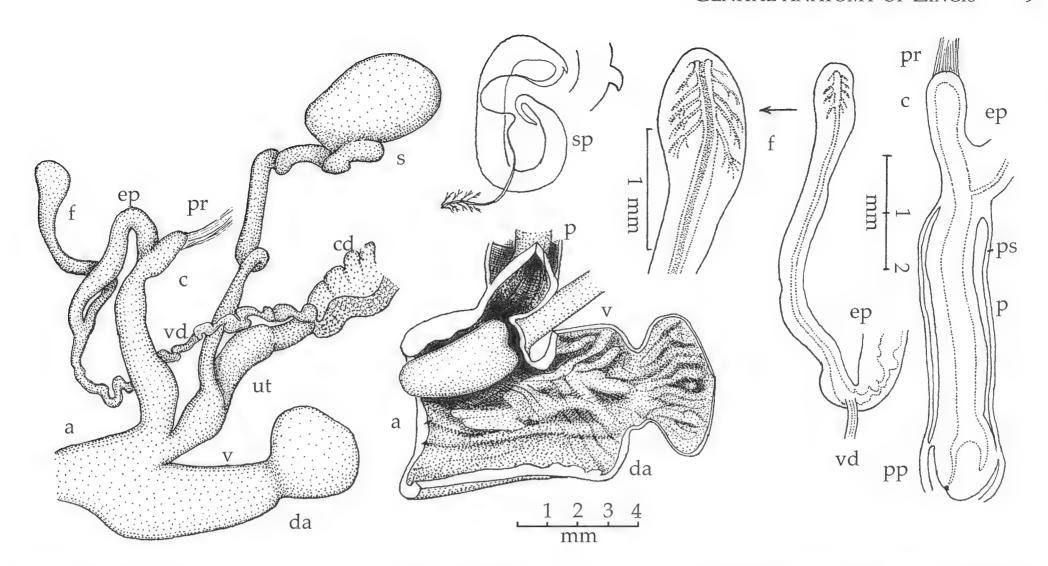


Fig. 8 Zingis (Fuellebornia) sesquicincta (von Martens), Tanzania, genital anatomy (after Van Mol).

Zingis (Chirinda) subg. nov.

Type species Zingis chirindensis van Bruggen & Verdcourt

Zingis chirindensis van Bruggen & Verdcourt, 1968 258, Figs 1–10 (Figs 5, 10B).

Shell helicoid, the protoconch with very fine spiral striae, the rest finely shagreened (the original authors of the type species stated protoconch without spiral lines); body whorl not keeled. Penial gland absent but an accessory appendage present within the sheath; retractor attached to middle of epiphallus; caecum absent; flagellum specialised, a stout curved organ with a series of ridges and very short rounded appendage, without internal branched diverticula; spermatophore unknown. Marginal teeth of radula with ectocone distinct and not distant from the main cusp.

Zingis (Morrumbalia) subg. nov.
Type species Zingis morrumbalensis (Melvill & Ponsonby)

Zingis morrumbalensis (Melvill & Ponsonby) Connolly 1939: 153 (Fig. 6, 10A). Nanina morrumbalensis Melvill & Ponsonby, 1894: 90, pl. 1, Fig. 1. ?Thapsia morrumbalensis Watson, 1934: 194. Zingis brunneofasciata Verdcourt, 1961: 120, Figs 1–3. (Fig. 7, 10E).

Shell helicoid, the protoconch with fine microspiral lines or without scupture; body whorl not keeled. Penial gland absent; retractor attached at apex of a short caecum (caecum 1); flagellum specialised, a broad wrinkled tube with numerous diverticula either throughout or in the proximal ½; spermatophore known in only one species -sausage-shaped with long attenuate ends but with dendritic appendages at base and apex of each. Marginal teeth of radula with side cusp prominent and not distant from main cusp.

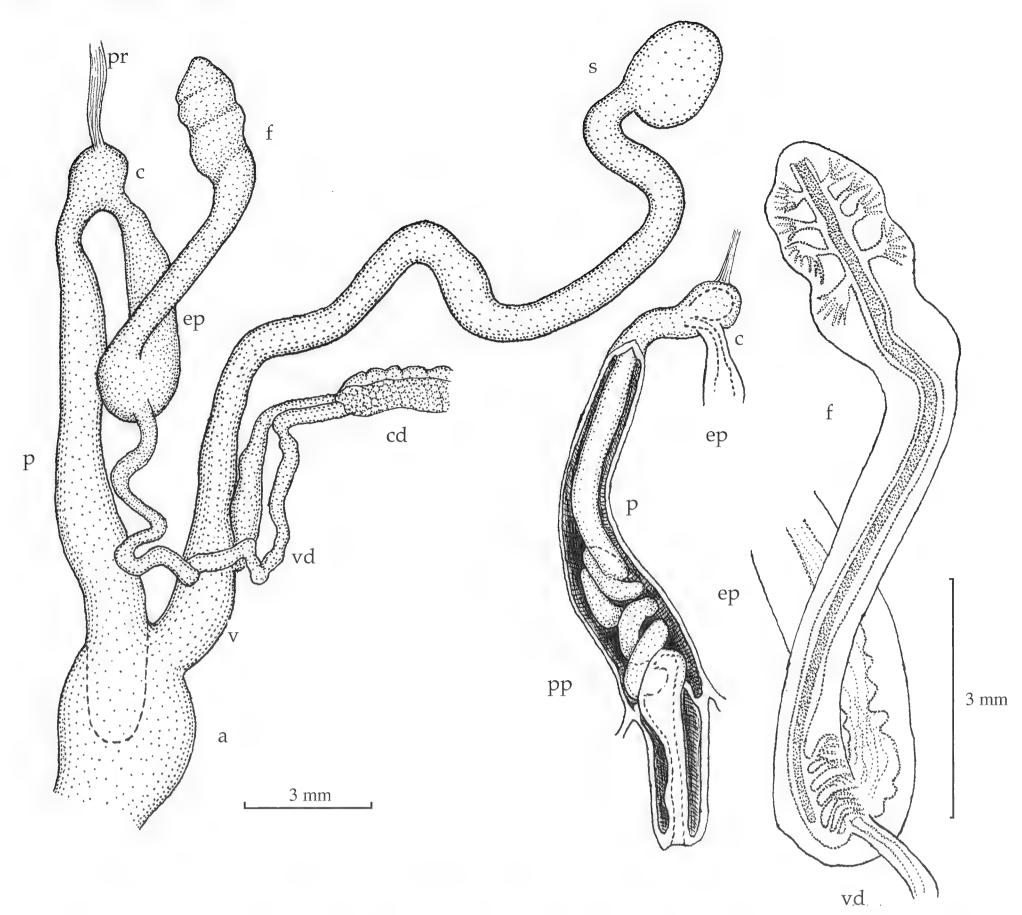


Fig. 9 Zingis (Subg. A). Zimbabwe, Inyanga, genital anatomy (after Van Mol)

Zingis (Fuellebornia) subg. nov. Type species Zingis sesquicincta (von Martens)

Zingis sesquicincta (von Martens, ) (Fig. 8, 10D).

Helix sesquicincta von Martens, 1900: 117.

Helix binaria von Martens, 1900: 179.

Zingis aureofusca (von Martens, ).

Macrochlamys aureofusca von Martens 1900: 178.

This may belong here but is unknown anatomically.

Shell helicoid, the protoconch microspirally striate; body whorl not keeled. Penial gland absent; retractor attached at apex of short caecum (caecum 1); flagellum long with a clavate apex, not constricted externally but internally with numerous branched diverticula at apex; spermatophore sausage-shaped with long attenuate tails with some dendritic appendages at ends. Marginal teeth of radula with lateral cusp reduced to a very small nick or virtually obsolete.

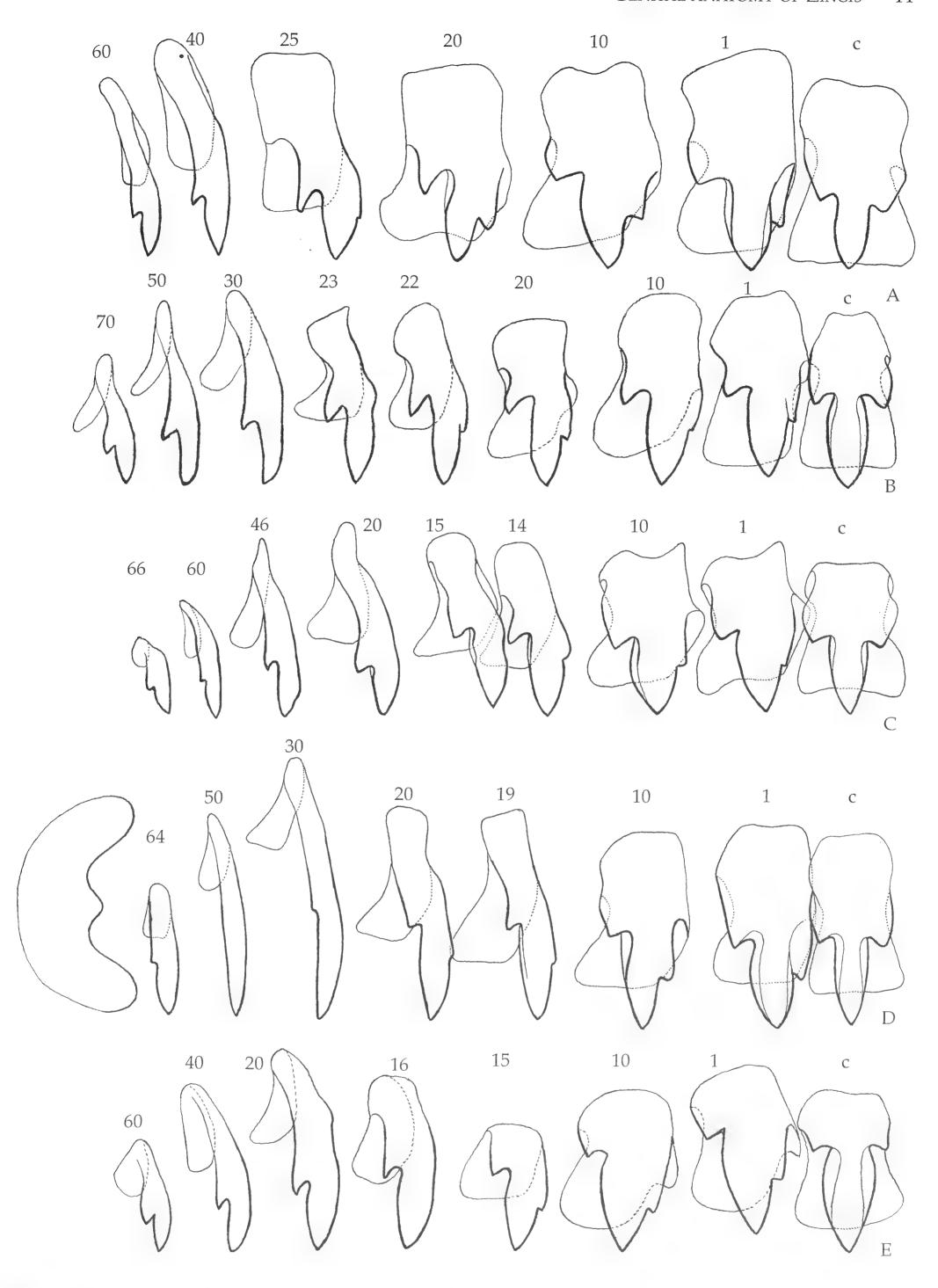


Fig. 10 Radulae of Zingis spp. A Z. morrumbalensis. B Z. chirindensis. C Undescribed species (Subg. A). D Z. sesquicincta. E Z. brunneofasciata (all after Van Mol).

#### Zingis (Tropidocochlion) subg. nov. Type species Zingis depressa (Germain)

Zingis depressa (Germain, 1916) (Figs. 1, 2, 3, 4). Trochonanina germaini C.R. Boettger var. depressa Germain, 1916: 250.

Shell helicoid, the protoconch with fine microspiral lines; body whorl strongly keeled, the base of the shell taller than the spire; shell with a fine microdecussate moiré sculpture. Penial gland absent; retractor attached at apex of a fairly short caecum (caecum 1); flagellum very long and narrow, not wrinkled; spermatophore sausage-shaped, with narrowed ends without appendages. Marginal teeth of radula with small lateral notch-like ectocone remote from the main cusp.

#### Zingis subg. A

Shell helicoid, the protoconch finely shagreened, body whorl not keeled. Penial gland absent; retractor attached to the apex of a very short caecum (caecum 1), flagellum long with clavate tip, internally with two zones of branched diverticula in the tip; spermatophore not known. Marginal teeth of radula with ectocones evident and not distant from the main cusp. (Figs 9, 10C).

This is based on an undescribed species which Van Mol intended to describe from material collected in Zimbabwe, Inyangani, 2500 m, leg. G.M.F. Mees, RRNH Leiden RG No. 1896 (3 sp.). Unfortunately this material has since been lost. The area is very well known and it seems likely that there is material preserved somewhere or, if not it will ultimately be recollected. Until further material is discovered this species and subgenus are best left undescribed although there is a full description of both shell and animal.

#### **ACKNOWLEDGEMENTS**

My thanks are due to Frontier Tanzania for providing the material, to the Laboratoire de Malacologique, Muséum National d'Histoire Naturelle, Paris for loaning a syntype of Zingis depressa and to G. Lewis and A. McRobb for providing photographs of it. I am very grateful to Jacqueline Sims of the palynology laboratory at the Royal Botanic Gardens, Kew for preparing SEMs from my stubs. Dr. J.J. Van Mol of the Université Libre, Brussels kindly gave me the manuscript and drawings relating to the second unpublished part of his revision. This will be deposited in the National Museum of Wales, Cardiff; it contains extremely detailed shell and anatomical descriptions of the species concerned.

#### REFERENCES

- BOETTGER C.R. 1913 Descriptions of new species of land shells from Africa *Proceedings of the Malacological Society. London* **10**: 348–353.
- Connolly M. 1939 A monographic survey of South African non-marine Mollusca *Annals of the South African Museum*. *Cape Town* **33**: 1–660, pls 1–19.
- GERMAIN L. 1916 Contributions à la faune malacologique de l'Afrique équatoriale. XLIV. Mollusques terrestres recueillis dans les provinces de Kilwa et de Mahenge (Afrique orientale) Bulletin du Muséum National d'Histoire Naturelle, Paris 22: 243–259.
- LOPEZ A. ORTIZ DE ZARATE 1951 Contribuciones al conocimiento de la fauna malacologica terrestre

- de la isla de Fernando Poo Boletin de la Real Sociedad Española de Historia Natural. Madrid 49: 101–121.
- Melvill J.C. & Ponsonby J.H. 1894 Descriptions of fifteen new species of South African terrestrial Mollusca *Annals and Magazine of Natural History* (6) **14**: 90–95.
- Pilsbry H.A. 1919 A review of the land mollusks of the Belgian Congo *Bulletin of the American Museum of Natural History* **40**: 1–370, pls 1–23.
- Tomlin J.R. le B. 1915 Description of a new species of *Peltatus* from British East Africa *Proceedings* of the Malacological Society. London **11**: 319–320.
- VAN BRUGGEN A.C. & DE WINTER A.J. 1990 *Carinazingis regalis* nov. gen. nov. spec. from Malawi, an urocyclid snail with a frontal organ and not belonging to *Gymnarion* (Mollusca, Gastropoda, Pulmonata: Urocyclidae) *Proceedings. Koninklije Nederlandse Akademie van Wetenschappen. Amsterdam* **93**: 235–252.
- VAN BRUGGEN A.C. & VERDCOURT B. 1968 On a new snail from Rhodesia Zingis chirindensis (Mollusca, Urocyclidae) Revue de Zoologie et de Botanique Africaine 78: 357–364.
- Van Goethem J.L. 1977 Recherches systématiques sur les Urocyclinae (Mollusca, Gastropoda, Urocyclidae) Annales de la Société Royale Zoologique de Belgique. Bruxelles 106: 123–132, figs 1–4.
- VAN GOETHEM J.L. 1977b Révision systématique sur les Urocyclinae (Mollusca, Gastropoda, Urocyclidae) Annales Musée Royal de l'Afrique Centrale. Tervuren sér 8° Sci Zool No 218, i–xi, 1–355, figs I–XX, figs 1–720, pls I–IV.
- VAN MOL J.-J. 1970 Révision des Urocyclidae (Mollusca, Gastropoda, Pulmonata). Anatomie-Systématique-Zoogéographie, Première Partie *Annales Musée Royal de l'Afrique Centrale. Tervuren* ser 8° **180**: 1–234, figs 1–158.
- VAN MOL J.-J. Ibidem Deuxième Partie (unpublished MS.).
- VERDCOURT B. 1961 A new species of Helicarionidae from Portuguese East Africa together with a discussion of the affinities of several other East African species *Journal de Conchyliologie* **101**: 120–134.
- VERDCOURT B. 1982 Notes on East African land and freshwater snails: 12-15 Zoologische Mededeelingen. Leiden 56: 217–236.
- VERDCOURT B. 1984 A contribution to the anatomy of *Trochozonites* Pfeffer (Mollusca, Urocyclidae) *Revue de Zoologie Africaine* **98**: 243–245.
- VERDCOURT B. 1986 Notes on *Trochonanina densestriata* Thiele (Mollusca, Urocyclidae) and some deceptively similar species *Revue de Zoologie Africaine* **99**: 337–344.
- Verdeurt B. 1990 An undescribed snail from Tanzania Conchologists' Newsletter 112: 261–265.
- VERDCOURT B. 1991 Zingis radiolata von Martens (Pulmonata, Urocyclidae ) a species much needed preserved in spirit *Conchologists' Newsletter* **119**: 426–428.
- VERDCOURT B. 1992 The rediscovery and anatomy of *Trochonanina gwendolinae* (Preston) (Pulmonata: Urocyclidae) *Journal of Conchology* **34**: 179–182.
- Von Martens E. 1878 Ubersicht der von Hrn J.M. Hildebrandt während seiner letzten mit Unterstützung der Akademie in Ostafrika ausgeführten Reise gesammelten Land und Süsswasser-Conchylien; presented at sitting of the Akademie 4 April 1878. Monatsberichte der Königlichen Preussischen Akademie der Wissenschaften zu Berlin 1878 288–299.
- Von Martens E. 1900a Einige neue Arten südafrikanischer Landschnecken. Sitzungsberichte der Gesellschaft Naturforschender Freunde zu Berlin 1900: 117–119.
- Von Martens E. 1900b Einige neue von Dr. Fülleborn in Deutsch-Ostafrika gesammelte Landschnecken Sitzungsberichte der Gesellschaft Naturforschender Freunde zu Berlin 1900: 177–180.
- Watson H. (in Connolly) 1925 The non-marine Mollusca of Portuguese East Africa *Transactions of the Royal Society of South Africa* **12**: 105–220.
- Watson H. 1934 *Natalina* and other Southern African snails *Proceedings of the Malacological Society. London* **21**: 150–198.

## A NEW SPECIES OF *PERSICULA* FROM THE VENEZUELAN REGION (GASTROPODA: CYSTISCIDAE)

F. BOYER<sup>1</sup>, J. NEEFS<sup>2</sup> & A. WAKEFIELD<sup>3</sup>

Abstract Persicula henneqini, a new species of Cystiscidae from Islas Los Roques in the Southern Lesser Antilles is described, including a comparison with close species and a summary of the complex of Persicula interruptolineata Megerle, 1816 from the Caribbean and Panamic Provinces.

Key words Marginelliform gastropods, Persicula hennequini n. sp., Cystiscidae, Venezuela.

#### Introduction

The recent work on the Revision of the Supraspecific Classification of Marginelliform Gastropods (Coovert & Coovert, 1995) divides these molluscs into two major groups, the Marginellidae and the Cystiscidae, the separation being made by distinct features of the radula, internal shell structure and columellar plications.

Two recent works have dealt in general terms with marginelliform gastropods from the Venezuelan region. In 1984, Talavera and Princz described a new species of Marginellidae from Venezuelan waters, *Marginella lassallei* n. sp. a small, heavily ribbed shell belonging to the genus *Dentimargo* Cossmann, 1899. This is probably a junior synonym of *Marginella sulcata* d'Orbigny, 1842. In the same work, the authors listed 26 species of marginelliform gastropods from 7 genera, but the distribution appears to be very discontinuous and smaller species appear to have been omitted. Nevertheless, this paper provides a useful baseline from which to work, and upon which extra information on the fauna of these microgastropods from this important coastal area can be added.

In 1988, De Jong and Coomans published their book on gastropods from Aruba, Bonaire and Curaçao (ABC Islands), listing 33 species of marginelliform gastropods in 11 genera, mainly from coastal and infralittoral zones. Several species are considered to be endemic to the ABC islands. Aruba has a slightly different fauna, which might be expected due to its proximity to the Venezuelan mainland coast (Peninsula de Paraguana). However, the fauna of the remainder of the Southern Lesser Antilles, namely Archipelago Los Aves, Islas Los Roques, Isla Orchila, Isla Blanquilla, and Islas Los Testigos, and from the Venezuelan mainland coast remains very poorly known. More collecting expeditions and field studies are therefore needed from this area.

The discovery of new species of marginelliform gastropods in the Venezuelan region remains quite possible, even in shallow water, and recognized species could have their distribution extended.

The archipelago of Los Roques is included in the Southern Lesser Antilles chain roughly half way between the ABC islands and Margarita Island (Fig. 1). Recent field trips here have revealed some species apparently new to science, from several different families. Very few marginelliform gastropods were obtained from shallow water, with only two species principally found: *Volvarina rubella* C.B. Adams, 1845 and a small *Persicula* which has been considered to be a variety of *Persicula chrysomelina* Redfield, 1848, yet presenting a deeply different pattern of decoration. The authors believe that this relatively isolated population of *Persicula constitutes* a new species, here described and belonging to the complex of *Persicula interruptolineata* Megerle, 1816.

<sup>&</sup>lt;sup>1</sup> 110 Chemin du Marais du Souci, 93270, Sevran, France.

<sup>&</sup>lt;sup>2</sup> Poolseweg 158, 4818 CE, Breda, The Netherlands.

<sup>&</sup>lt;sup>3</sup> 14 Forest Side, Buckhurst Hill, Essex, IG9 5SL, England.

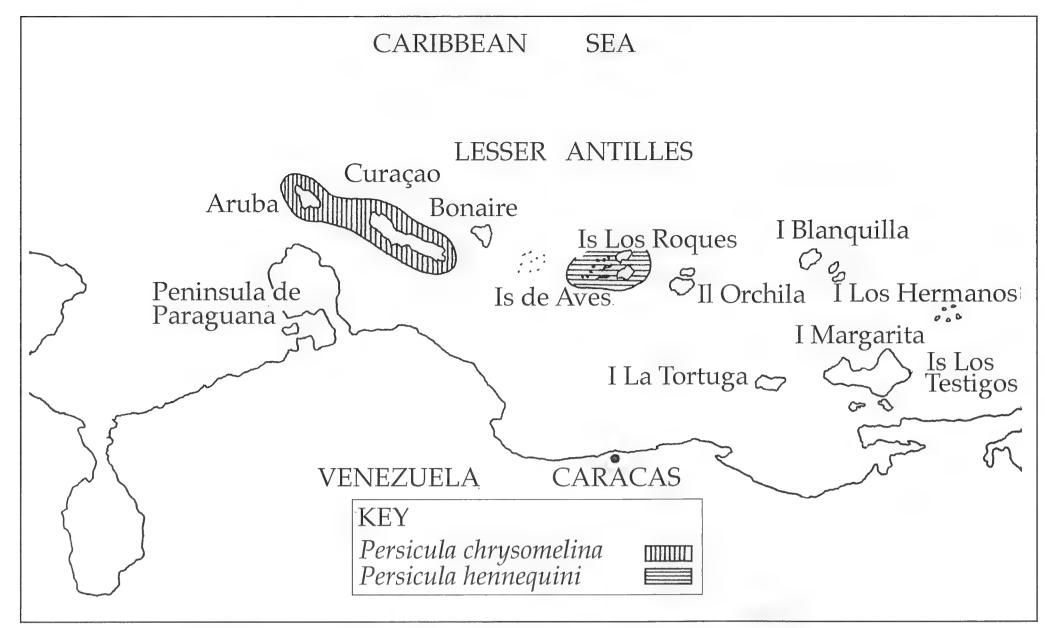


Fig. 1 The Venezuelan mainland coast and associated islands

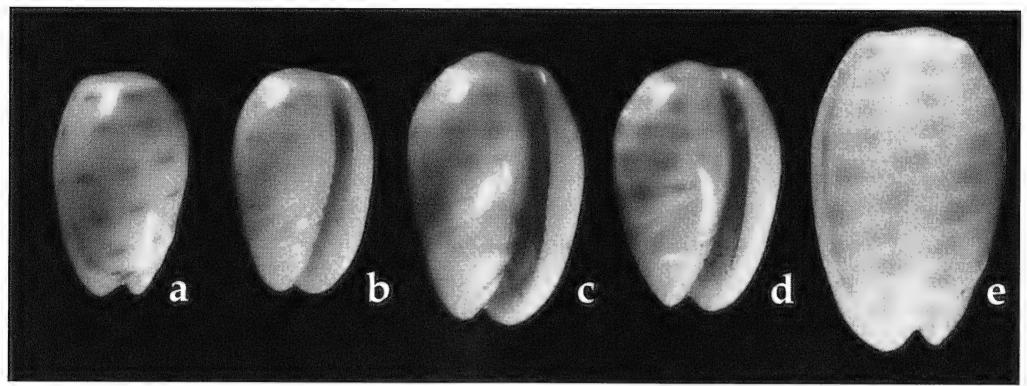
#### Systematic Description

Cystiscidae Persiculinae

Genus *Persicula* Schumacher, 1817 Type species *Persicula persicula* Linnaeus, 1758

Diagnosis Shell small to large and moderately to very solid. Coloured uniformly or intricately patterned. Spire submerged and lip thickened. External varix present or absent. Siphonal notch deep. Posterior notch present. Up to 13 columellar plications plus parietal lirae. Animal has a flattened head, longitudinally divided into two lobes, with long siphon and short tentacles. The mantle appears not to extend over the external shell surface (Type 4 Animal of Coovert & Coovert 1995).

Remarks Few rules are given for the conchological and anatomical features which separate the genera *Persicula* Schumacher, 1817 and *Gibberula* Swainson, 1840 (Type species: *G. zonata* Swainson, 1840 = *Volvaria oryza* Lamarck, 1822). The genera are generally accepted as being separable on shell morphology alone. *Persicula* species are larger, always with a deep siphonal notch bordered by a well pronounced labial margin. This labial margin is well defined from the rest of the shell by a groove on the external lip. The spire is submerged making the rounded apex quite indistinct. *P. chrysomelina* and the proposed new species both present these characters, which are not found in specimens of *Gibberula*. Animals from both genera exhibit the same external features, in particular a bilobed head and short tentacles, and both have small arched radular plates bearing few cusps.



**Fig. 2a–b** *Persicula hennequini* n. sp. (Holotype 1.215.18, Cambridge University Museum of Zoology). c *P. hennequini* n. sp. Los Roques Is. Venezuela. 6.15 x 4.15 mm. d *P. chrysomelina*. Curacao. 6.35 x 4.25mm. e *P. chrysomelina*. Malmok, Aruba. 6.5 x 4.2 mm.

### Persicula hennequini n. sp. Figs 2a-c.

Holotype 1 sp, Los Roques Islands, Venezuela. 2 metres on sand in sheltered bay, ex. coll. Hennequin. Deposited in Cambridge University Museum of Zoology, Cambridge, England. Type Collection Reference No. 1.215. 18.

Paratypes 6 sp, locality as Holotype, collections Boyer (France), Neefs (Holland) and Wakefield (England).

Type Locality Los Roques Islands, Southern Lesser Antilles, Caribbean.

Other Material Examined In private collections of Boyer (France), Bozzetti (Italy), Gratecap (France), Pin (Senegal), Hennequin (France). Locality as Holotype.

#### Measurements

	Length (mm)	Width (mm)
Holotype	5.70	3.60
Paratype 1	5.65	3.50
Paratype 2	5.75	3.50
Paratype 3	6.50	4.30
Paratype 4	6.10	4.00
Paratype 5	7.20	4.65
Paratype 6	6.10	4.00

Description Shell solid and highly polished. Sub-cylindrical to sub-pyriform. 5.5 to 8 mm in length, 3 to 5 mm in width. Colour porcellanous grey-white. Four to five regularly spaced rows of light brown dashes on body whorl. Spire depressed and rounded. Suture slightly raised on the body whorl. On early whorls, suture flattened to moderately produced, and translucent. Labrum raised, angular. Outer lip strongly marginated, extending anteriorly to deep siphonal notch. Aperture slightly arched, widening slightly anteriorly. Up to twenty denticles on inner edge of lip. Two strong anterior columellar plications, continuing posteriorly with four to five smaller plications. A deep groove borders the parietal callus on the ventral side of the shell.

Animal not observed.

18

Derivation of name The species is named for its discoverer, Mr Francis Hennequin.

Habitat As with all the species belonging to the group of *P. interruptolineata*, *P. hennequini* lives in sand. All the recorded specimens are from shallow water (2–3 m), in sheltered bays.

Geographic range So far only been recorded from Los Roques Islands, off the mainland coast of Venezuela, in the southern Lesser Antilles chain (Fig. 1).

Comparisons The animal of P. hennequini has not been studied, however the animal of P. chrysomelina, which is considered to be the closest related species is illustrated in Lipe and Abbott (1991). P. chrysomelina is not known from Los Roques or from the Venezuelan mainland coast, but has been collected in 3 metres at Malmok, Aruba (Boyer and Wakefield Collections) and at undetermined depths in Curação (Fig. 2d) where it is said to be 'rather common in somewhat deeper water' according to De Jong and Coomans (1988). The occurrence of *P. chrysomelina* in Bonaire has yet to be confirmed. *P. hennequini* should therefore be provisionally considered as endemic to the Los Roques Islands, just as P. chrysomelina is considered endemic to the ABC Islands. More studies are required to see if the range of these two species can be expanded to neighbouring areas. The possibility also exists that there may be intergrades between P. hennequini and P. chrysomelina. Perhaps the best place to look for these would be Los Aves which is equidistant from Bonaire and Los Roques. Alternatively, both species could be living sympatrically there, or indeed there may be a third closely related species. The colour patterns of both species are so distinctive in their structure that their phyletic relationship is probably not direct, and so the specific status of the two does not seem in doubt.

*Remarks* The discovery of *P. hennequini* confirms the great variety of species in the genus *Persicula* throughout American waters. The authors provisionally include *P. hennequini* in the complex of *P. interruptolineata*, which is tentatively sub-divided as follows:

The Persicula interruptolineata Group (Figs 3a-f).

Small species (6–8 mm) P. adamsiana Pilsbry & Lowe, 1932 from Western Panama and the corresponding or possibly conspecific species from Eastern Panama, P. adamsiana weberi Olsson & McGinty, 1958.

Medium species (9–17 mm) *P. imbricata* Hinds, 1844, *P. hilli*, M. Smith 1950, and *P. bandera* Coan & Roth, 1965, all from the Panamic Province from Mexico to Costa Rica, and the corresponding species from the Caribbean Province: *P. interruptolineata* from the southern Caribbean, *P. multilineata* Sowerby, 1846, from the Gulf of Honduras, and *P. obesa* Redfield, 1846, from northern Colombia to Trinidad.

Chequered species (12–19 mm) This group is composed of two closely related species, the shape of their shell being very close to that of *P. obesa* but presenting a very different chequered pattern of square grey to tan large patches rather than spiral lines or dashes. *P. accola* Roth & Coan, 1968 is known as a rather abundant species from the Panamic side of Costa Rica and western Panama. *P. porcellana* Gmelin 1791 (synonym *P. tessellata* Lamarck, 1822) is known as a somewhat scarce species from the Caribbean side of Panama to Trinidad.

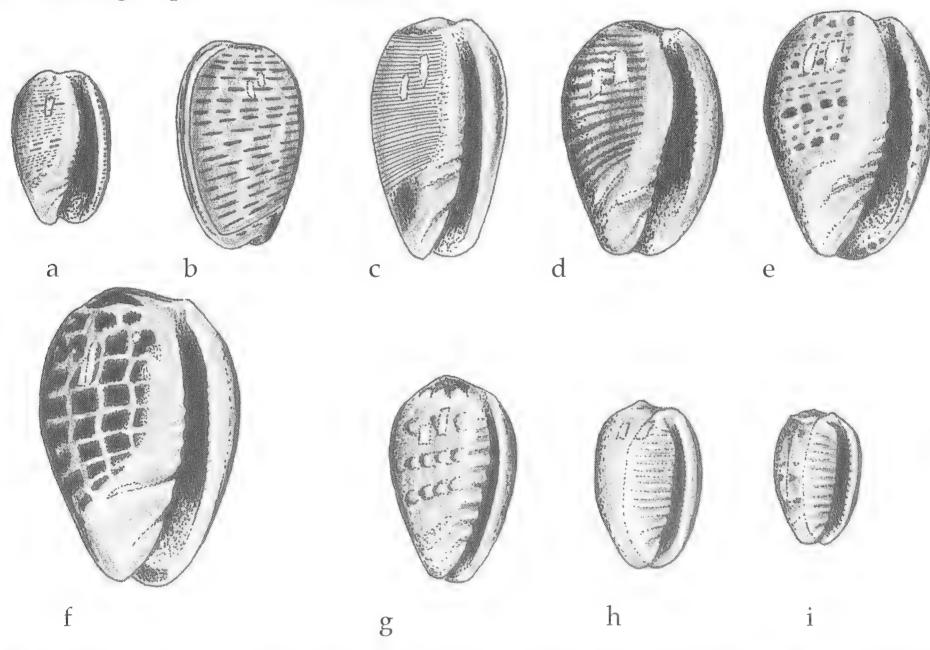
The Persicula Chrysomelina Group (Figs 2a-e)

*P. chrysomelina* and *P. hennequini* present original characters both in their decoration and shell morphology. These parameters are, however, not necessarily sufficient to render them independent of the complex of *P. interruptolineata*. Some slender specimens of *P. chrysomelina* from Curação exhibit wide continuous or broken red-brown spiral bands and patches, and are not too different from some specimens of *P. adamsiana* or *P. adam-*

siana weberi. Small and narrow specimens of *P. interruptolineata* are recorded from as far east as Tobago by Lipe and Sunderland (1991), where typical Venezuelan fauna is found. The occurrence of such a group in the southern Caribbean needs further study, and the position of *P. chrysomelina* within this group needs evaluation, as does the phyletic relationship of *P. hennequini* with other Caribbean *Persicula*.

PACHYBATHRON/PERSICULA KIENERIANA GROUP (Figs 3g-i)

Two other related groups are included from the same area: The genus Pachybathron Gaskoin, 1853 with three described species, and Persicula kieneriana Petit, 1838. Pachybathron tayrona Diaz & Velasquez, from northern Colombia, P. cypraeoides C.B. Adams, 1845 with Jamaica given as type locality but only recorded thereafter as coming from the ABC Islands, and P. cassidiforme Gaskoin, 1853 from St. Vincent. The recorded distribution of these species is fragmented, but in fact may prove to be more continuous. In the collection of one of the authors is a crabbed specimen of *Pachybathron*, apparrently similar to P. cypraeoides, which is recorded as coming from Callao, Peru. The occurrence of this genus in the southern Panamic Province is perfectly possible. Persicula kieneriana seems to be occurring in the Venezuelan Sea (with La Guaira recorded as type locality) to Trinidad and Tobago. Records from northern Brazil have to be confirmed. This species has a glossy, globose, colourful shell with an extremely narrow aperture, and presents intermediate features between the P. interruptolineata complex and the genus Pachybathron. The study of the behaviour and habitat of Pachybathron and of Persicula kieneriana would be of great importance in understanding the special adaptation of their shell, and for the reconstruction of the evolutionary history of Persicula and other related groups in the Caribbean Sea.



**Fig. 3a** *P. adamsiana weberi* Cabo Codera, Venezuela 7.0 x 4.0 mm **b** *P. interruptolineata* Tobago. 8.0 x 4.8 mm **c** *P. hilli* Manzanillo, West Mexico 11.6 x 6.7 mm **d** *P. bandera* Santa Cruz, West Mexico 11.3 x 7.4 mm **e** *P. obesa* Isla Margarita, Venezuela 11.5 x 7.8 mm **f** *P. accola* Isla Cebaco, Western Panama 13.7 x 9.0 mm **g** *P. kieneriana* Cabo Codera, Venezuela 9.65 x 5.9 mm **h** *Pachybathron cypraeoides* Aruba 7.8 x 4.7 mm **i** *Pachybathron cassidiforme* Bequia, St. Vincent & Grenadines 6.1 x 3.8 mm.

#### **ACKNOWLEDGEMENTS**

Macro photography by Franck Boyer, France (Figs 2a–d) and Jeroen Goud of the Department of Mollusca, Museum of Natural History, Leiden, Holland (Fig. 2e). Drawings by Andrew Wakefield. Thanks also due to Dr. Richard Preece of the Cambridge University Museum of Zoology, for much help and advice.

#### REFERENCES

- COOVERT G.A. & COOVERT H.K. 1995 Revision of the Supraspecific Classification of Marginelliform Gastropods *The Nautilus* **109** (2+3): 43–110.
- DE JONG K.M. & COOMANS H.E. 1988 Marine Gastropoda from Curacao, Aruba, and Bonaire E.J. Brill, Leiden 261 pp., 47 pls.
- LIPE R. & SUNDERLAND K. 1991 Caribbean Marginellidae American Conchologist 19 (2): 14–15.
- LIPE R. & TUCKER ABBOTT R. 1991 Living Shells of the Caribbean and the Florida Keys American Conchologist Inc. Publication.
- Talavera F. & Princz D. 1984 *Marginella lasallei* spec. nov y Revision de la Familia Marginellidae en el Mar Venezolano *Bullettino Malacologico Milano* **20**: 273–282.

## A NEW MEDITERRANEAN *SKENEOIDES* (GASTROPODA: SKENEIDAE) FROM A SHALLOW-WATER CAVE

#### R. La Perna<sup>1</sup>

Abstract A new skeneimorph gastropod is described from a shallow-water cave in the Ustica Island (southern Tyrrhenian Sea), Skeneoides digeronimoi. It differs from S. exilissima (Philippi, 1844) and S. jeffreysi (Monterosato, 1872) by being almost lacking in spiral sculpture and is more high-spired. Although found as empty shells, S. digeronimoi n. sp. is believed to belong to the cave community, and not to the allochthonous shell material, also present within the cave.

Key words Skeneoides, Skeneidae, New species, Cave molluscs, Mediterranean.

#### Introduction

The molluscan fauna from the Mediterranean submarine caves was formerly believed to be lacking in peculiarities (e.g. Cattaneo Vietti & Russo, 1987). Probably no Mediterranean mollusc will prove to be exclusive to cave environments, but the shallow-water caves anyway represent a "refuge" (Harmelin *et al.*, 1985) for a number of "uncommon" species, among which body-size reduction (miniaturisation, paedomorphosis), brooding, cryptic habits and deep-sea affinities are frequent, as also stressed by Kase & Hayami (1991) and Hayami & Kase (1993, 1996) for the Japanese cave molluscs.

New malacological data from the Mediterranean caves have been recently reported, such as a smooth-shelled and colourless ecotype of the gastropod *Homalopoma sanguineum* (Linné, 1758) by Di Geronimo *et al.* (1997), a new hyalogyrinid gastropod by Warén *et al.* (1997) and the new miniaturised arcid *Asperarca magdalenae* by La Perna (1998). Also the occurrence of the paedomorphic mytilid *Dacrydium hyalinum* (Monterosato, 1875) (Di Geronimo *et al.*, 1997; Warén *et al.*, 1997) should be remarked, as this genus typically comprises deep-sea species (Salas & Gofas, 1997). Another paedomorphic bivalve, *Nucula recondita* Gofas & Salas, 1995, also proves to be common within cave assemblages (Di Geronimo *et al.*, 1997; La Perna, unpubl. data).

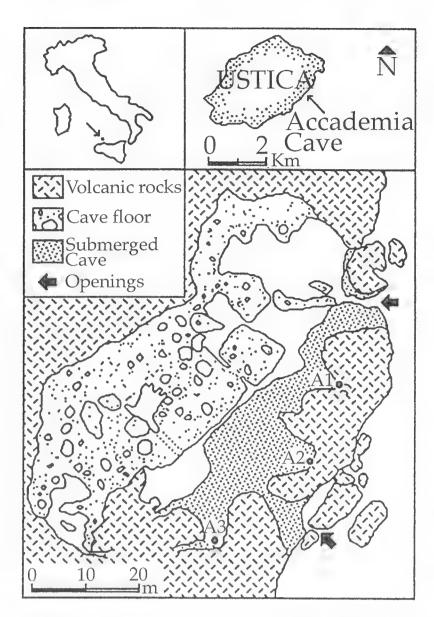
A small gastropod was found in a shallow-water cave in the southern Tyrrhenian Sea. It proves to be an undescribed "skeneimorph", an informal group whose northeast Atlantic and Mediterranean species were monographed by Warén (1992). Also this species may prove to be a peculiar element of the Mediterranean molluscan cave assemblages.

#### MATERIAL AND METHODS

The examined material comes from a cave developing in pyrodastic rocks in the Ustica Island (Fig. 1), known as Grotta dell 'Accademia (Accademia Cave). The cave is *c*. 40 m long and with two narrow openings, the main one at sea level, the other at a few metres depth. Part of the cave is semi-submerged, forming shallow "lakes", while the wholly submerged part does not exceed 3–4 m in depth (Colantoni *et al.*, 1989).

Investigations on the benthic assemblages (molluscs, bryozoans and serpuloideans) from the Accademia Cave were carried out by Di Geronimo *et al.* (1994; 1997), who

<sup>&</sup>lt;sup>1</sup> Istituto Policattedra di Oceanologia e Paleoecologia, Università di Catania, Corso Italia 55, I-95129 Catania, Italy.



**Fig. 1** Location and topography of the Accademia Cave (modified from Colantoni *et al.*, 1989). A1, A2 and A3 are the sampling sites of Di Geronimo *et al.* (1997).

pointed out compositional discrepancies between community and thanatocoenosis, the former fitting a "typical" cave assemblage, the latter largely consisting of allochthonous species, mainly from vegetated bottoms. Allochthony of thanatocoenosis proves to be related to distance from the openings. A largely autochthonous (c. 90%) thanatocoenosis prevails only in the innermost and more sheltered part (site A3, see Fig. 1). Sediment texture also proves to be related to the "confinement degree" (see Bianchi & Morri, 1994), being muddy in the innermost site and sandy in the less confined ones.

The presently described species was found in the A3 site, from where it was listed as "undetermined skeneimorph" by Di Geronimo *et al.* (1997: Table 1). Additional specimens were later sorted from other bottom material from the same site.

Specimens selected for SEM observations were treated with dilute bleach, mounted on stubs and gold-coated. Measurements were taken from SEM pictures.

#### Systematic Description

Gastropoda Vetigastropoda Skeneidae

Genus *Skeneoides* Warén, 1992 Type species *Delphinula exilissima* Philippi, 1844 by O.D.

*Skeneoides digeronimoi* n. sp. Figs 2–13

Holotype University Palaeontological Museum, Catania.

Paratypes 8 specimens as holotype.

Type locality Inside the Accademia Cave, Ustica Island, southern Tyrrhenian Sea, 3–4 m.

Material examined Only the type-series, consisting of empty shells.

Measurements Holotype 0.93 mm in diameter, 0.74 mm in height.

Description Shell very small, skeneimorph, tall-spired, whitish, vitreous, slightly glossy. Protoconch of 1.5 whorls, c. 270  $\mu$ m in diameter, pitted, nucleus slightly distorted. Teleoconch of up to 1.5 whorls rather loosely coiled. Sculpture of strong ringlike axial ribs (c. 30 in the holotype), more and more wide-spaced with growth, weaker to ill-

defined near aperture. A weak to ill-defined dorsal spiral rib, often replaced by a series of weak knobs on axial ribs. A similar series of knobs also present on base. Microsculpture of closely set granules roughly axially aligned. Umbilicus wide and deep. Aperture circular, radial; lip thin.

Derivation of name Named for Prof. S.I. Di Geronimo, who introduced me to cave mollusc study.

Taxonomy Based on shell morphology, the present species can be allocated in the family Skeneidae, as treated by Hickman & McLean (1990) and Warén (1992; 1993). Shell morphology also supports its position in *Skeneoides* Warén, 1992. This genus was erected to allocate low-spired and strongly sculptured skeneids, which also show anatomical and radular differences from other morphologically similar skeneimorphs (Warén, 1992). Two other species of *Skeneoides* are known from the Mediterranean (Warén, 1992), i.e. *S. exilissima* (Philippi, 1844) and *S. jeffreysi* (Monterosato, 1872). The distorted protoconch nucleus of *S. digeronimoi* (Figs 12, 13) is worth stressing. Warén (1992) remarked this feature for the skeneid genus *Lodderena* Iredale, 1924, but it also appears typical to *Skeneoides* (see *S. exilissima* and *S. jeffreysi* in Warén 1992: Figs 9b, 9c). Also the "axial" granulouse microsculpture (Figs 8, 11) is typical for the genus (Warén, 1992). The "lacking" of a spiral sculpture in *S. digeronimoi* should be noted, as "4 to 12 strong spiral ribs" were originally remarked for *Skeneoides*. However, "relicts" of a spiral sculpture can be traced in the present species too.

Geographic range Only known from the type locality.

Remarks The spiral sculpture is poorly developed. A true spiral cord, much fainter than the axial ribs, may be present dorsally throughout the teleoconch or only in the early stage (Fig. 12), or it may be quite lost (Fig. 4). Faint knobs (Figs 2–8), giving an obscurely angulate whorl profile often replace it. Fainter knobs may also develop on the base. The axial ribs prove to be somewhat irregular at SEM, and each often with one or two "secondary" ribs (Figs 8, 10). Ribs may rarely become bifurcate (Fig. 9). Moderate variations in shape also occur (Figs 2–7).

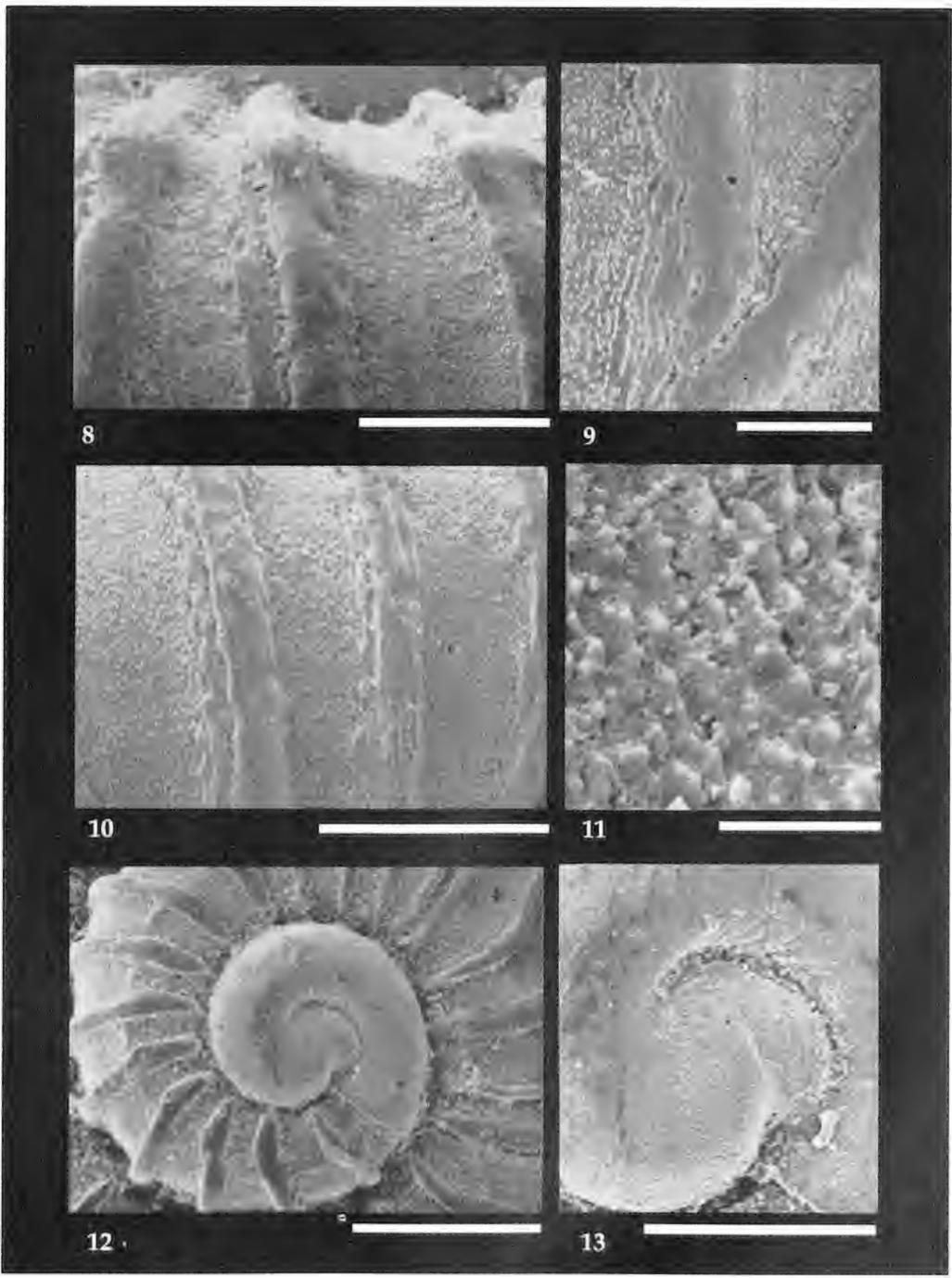
Owing to the strong spiral sculpture, the present species is more similar to S. jeffreysi than to S. exilissima. The former, anyway, has well-defined spiral ribs throughout the shell, crossing the axial sculpture (where knobs develop) and giving a reticulate appearance. It is also notably flatter (height/diameter c. 0.5) than S. digeronimoi (h/d 0.7–0.8). Also S. exilissima is flatter (h/d c. 0.6), the axial sculpture is weaker and a well-defined spiral sculpture, almost equal in strength to the axial one, is present. The protoconch size of S. digeronimoi is comparable to that of S. exilissima and S. jeffreysi.

#### **DISCUSSION**

In spite of the small size, which would allow the shells of *S. digeronimoi* to be easily displaced to the innermost cave parts, it seems more likely that this species is an autochthonous element instead. First, it should be noted that the rich tanathocoenoses from the less sheltered sites A1 and A2 did not yield any shells of *S. digeronimoi*. The depauperate bottom tanathocoenosis occurring in the A3 site largely consists of sciaphilous sessile species, clearly coming from the surrounding cave walls. Further evidence of the ecological peculiarity of site A3 is provided by the occurrence of three bivalves, namely *Dacrydium hyalinum*, another paedomorphic mytilid (?= "*Crenella*"



Figs 2–7 Skeneoides digeronimoi n. sp. 2–4 Holotype (diameter 0.93 mm, height 0.74 mm). 5 Paratype (diameter 0.89 mm, height 0.70 mm). 6 Paratype (diameter 0.97 mm, height 0.71 mm). 7 Paratype (diameter 0.94 mm, height 0.73 mm).



**Figs 8–13** *Skeneoides digeronimoi* n. sp. 8 Holotype, sculpture detail. 9 Paratype, sculpture detail. 10 Holotype, sculpture detail. 11 Microsculpture of the same specimen. 12 Paratype, top view and protoconch. 13 Protoconch detail of the same specimen. Scale bars = 8, 10, 13, 100  $\mu$ m; 9, 50  $\mu$ m; 11, 10  $\mu$ m; 12, 200  $\mu$ m.

arenaria Monterosato, 1875) and the micromorphic *Kelliella abyssicola* (Forbes, 1844) (Di Geronimo *et al.*, 1997). These species can be regarded as a stock of deep-sea affinity and related to the fine-grained bottom. In the same site the paedomorphic brachiopod *Tethyrhynchia mediterranea* Logan, 1994 (known from dark Mediterranean caves; Logan & Zibrowius, 1994) is also common. All this provides a ground to assume *S. digeronimoi* to be an element of the cave community living in the darker and more confined parts. One might anyway expect to find it on a number of substrates outside the caves, such as crevices, coralligenous bottoms and deep-shelf bottoms.

#### **ACKNOWLEDGEMENTS**

I am grateful to Mr R. Leonardi (Catania University), for having technically supported the cave sampling, to Mr Orazio Torrisi for SEM assistance, to Dr H. Zibrowius (Station Marine d'Endoume) for brachiopod determinations, and to Dr T. Kase (National Science Museum, Tokyo) for help in bibliography and useful discussions. Thanks are also due to Prof. S.I. Di Geronimo, Dr A. Rosso (Catania University) and to Dr A. Warén (Swedish Museum of Natural History) for critical readings and comments.

Work supported by C.N.R. Grants to Prof. S.I. Di Geronimo.

#### **ADDITIONAL**

While the present article was in press, Dr Winfried Engl called my attention on *Skenea nilarum* Engl, 1996 (*La Conchilgia*, 280: 21–23), of which I examined some specimens. *S. nilarum* is a shallow-water species from Lanzarote, Canary Islands. It is notably similar to *Skenoides digernimoi*, from which it differs by being much flatter, with thinner and more raised ribs, and by lacking spiral sculpture. No anatomical data are available. I express my thanks to Dr W. Engl for his kind help.

#### REFERENCES

- BIANCHI C.N. & MORRI C. 1994 Studio bionomico comparativo di alcune grotte marine sommerse: definizione di una scala di confinamento *Memorie dell'Istituto Italiano Speleologia*, s. 2 6: 107–123.
- Cattaneo Vietti R. & Russo G.F. 1987 Molluscs from submarine caves of the Sorrentine peninsula (Southern Tyrrhenian Sea) *Stygologia* **3**: 138–148.
- Colantoni P., Gamba R. & Alvisi M. 1989 Rilevamento e aspetti geomorfologici della Grotta dell' Accademia e del complesso sotterraneo della Pastizza Quaderni dell'Accademia Internazionale di Scienze e Tecniche Subacquee, Ustica 2: 5–16.
- DI GERONIMO I., LA PERNA R., ROSSO A. & SANFILIPPO R. 1994 Popolamento e tanatocenosi bentonica della Grotta dell' Accademia (Ustica, Mar Tirreno meridionale) *Il Naturalista Siciliano* s. 4 **17**: 45–63.
- DI GERONIMO I., ALLEGRI L., IMPROTA S., LA PERNA R., ROSSO A. & SANFILIPPO R. 1997 Spatial and temporal aspects of benthic thanatocoenoses in a Mediterranean infralittoral cave *Rivista Italiana di Paleontologia e Stratigrafia* 103: 15–28.
- Harmelin J.-G., Vacelet J. & Vasseur P. 1985 Les grottes sous-marines obscures: un milieu extrême et un remarquable biotope refuge *Téthys* 11: 214–229.
- HAYAMI I. & KASE I. 1993 Submarine cave Bivalvia from the Ryukyu Islands: systematic and evolutionary significance *University Museum*, *The University of Tokyo* **35**: 1–133.
- HAYAMI I. & KASE I. 1996 Characteristics of submarine cave bivalves in the northwestern Pacific.

- American Malacological Bulletin 12 (1-2): 59-65.
- HICKMAN C.S. & McLean J.H. 1990 Systematic revision and suprageneric classification of Trochacean Gastropods *Natural History Museum of Los Angeles County, Sci. Ser.* **35**: 1–169.
- Kase T. & Hayami I. 1991 Unique submarine cave mollusc fauna: composition, origin and adaptation *Journal of Molluscan Studies* **58**: 446–449.
- La Perna R. 1998 On *Asperarca* Sacco, 1898 (Bivalvia, Arcidae) and two new Mediterranean species *Bollettino Malacologico* **33** (1–4): 11–18.
- LOGAN A. & ZIBROWIUS H. 1994 A new genus and species of Rhynconellid (Brachiopoda, Recent) from submarine caves in the Mediterranean Sea *Marine Ecology* **15**: 77–88.
- SALAS C. & GOFAS S. 1997 Brooding and non-brooding *Dacrydium* (Bivalvia: Mytilidae): a review of the Atlantic species *Journal of Molluscan Studies* **63**: 261–283.
- Warén A. 1992 New and little known "skeneimorph" gastropods from the Mediterranean Sea and the adjacent Atlantic Ocean *Bollettino Malacologico* 27: 149–247.
- Warén A. 1993 New and little known mollusca from Iceland and Scandinavia. Part 2 Sarsia 78: 159–201.
- Warén A., Carrozza F. & Rocchini R. 1997 Description of two new species of Hyalogyrinidae (Gastropoda, Heterobranchia) from the Mediterranean *Bollettino Malacologico* 32: 57–66.



# A NEW SPECIES OF *PARENNEA* PILSBRY (GASTROPODA: STREPTAXIDAE) FROM THE WEST USAMBARA MOUNTAINS, TANZANIA

#### P. Tattersfield<sup>1</sup>

Abstract Ptychotrema (Parennea) mazumbaiense is described as a new species from Mazumbai Forest, in the West Usambara mountains, north-east Tanzania. It was collected from forest-floor leaf-litter in sub-montane forest habitat at an altitude of 1600–1700 m above sea level. It is the second species of Parennea reported from Tanzania and is characterised by its strong ribbing, the form of the sinus between the angular and palatal denticles, and the presence of a deeply set, elongated spiral palatal lamella which is not visible when viewed from shell aperture.

Key words Ptychotrema (Parennea) mazumbaiense n. sp., Streptaxidae, Tanzania.

#### Introduction

Parennea is a speciose and exclusively African group. It was erected by H.A. Pilsbry (1919) as a subgenus of *Ptychotrema* Mörch for species with a single palatal fold (the upper palatal), deeply entering the aperture, its place being marked externally by a single dorsal furrow. Partly for practical reasons, subsequent authors have continued to retain *Parennea* as a subgenus of *Ptychotrema* although van Bruggen (1989) concluded that the group is probably not monophyletic.

In 1978 Adam and Van Goethem published an illustrated revision of *Parennea* which included 34 species. Van Bruggen (1989) updated Adam and Van Goethem's treatise in which he recognised 43 species of *Parennea*, including several of uncertain status. Van Bruggen provided an analysis of *Parennea*'s biogeography and systematics, especially in relation to the discovery of several new species in Malawi, Zambia and Angola. Eight East African species were listed from East Africa in Verdcourt (1983) and Verdcourt (1958, 1961) contributed further data on several species and described two new species.

The central African forests, especially eastern Democratic Republic of Congo (formerly Zaire), are the stronghold of *Parennea* (van Bruggen, 1989) although its distribution is considerably more extensive and includes outlying species in west Africa (Liberia), Ethiopia, north Somalia and southern Malawi. It appears not to extend to southern Africa south of 16° S (van Bruggen, 1989). With the exception of a few species from Malawi and eastern D.R. Congo, relatively little is known about the detailed geographical distribution of individual species. Van Bruggen (1989) notes that 49% of the species are known only from their respective type localities.

This paper describes a new species of *Parennea* that was found in 1996 in a mid-elevation forest in the West Usambara mountains, north-east Tanzania.

#### Systematic Description

STREPTAXIDAE

Genus *Ptychotrema* Mörch, 1852 Subgenus *Parennea* Pilsbry, 1919

<sup>&</sup>lt;sup>1</sup> Department of Biodiversity and Systematic Biology, National Museum of Wales, Cathays Park, Cardiff CF1 3NP, UK.

#### Ptychotrema (Parennea) mazumbaiense n. sp.

Fig. 1a-d

Holotype NMW.Z.1998.021.00001 adult sh. Extracted from forest-floor leaf-litter by sieving. Leg. P. Tattersfield, 27.i.96.

*Paratype* One adult sh. collected at the same time as the holotype by sieving leaf litter from type locality. National Museum of Tanzania.

*Type Locality* Mazumbai Forest, West Usambara Mountains, Lushoto District, Tanzania. Location: 4° 50′ S 38° 30′ E at an altitude of 1600–1700 m asl.

Mazumbai Forest contains lower montane forest communities (Redhead, 1981) and extends over an area of *c*. 300 ha between 1300–1900 m asl in the West Usambaras. The forest is relatively undisturbed and contains many large trees, some exceeding 50 m in height. Emergent and upper-storey trees include *Allanblackia stuhlmanni* (Engl.) Engl., *Entandrophragma excelsum* (Dawe & Sprague) (mahogony), *Newtonia buchananii* (Bak.) Gilbert and Boutique and *Ocotea usambarensis* Engl. (East African camphor). Redhead (1981) gives mean annual rainfall as 1230 mm.

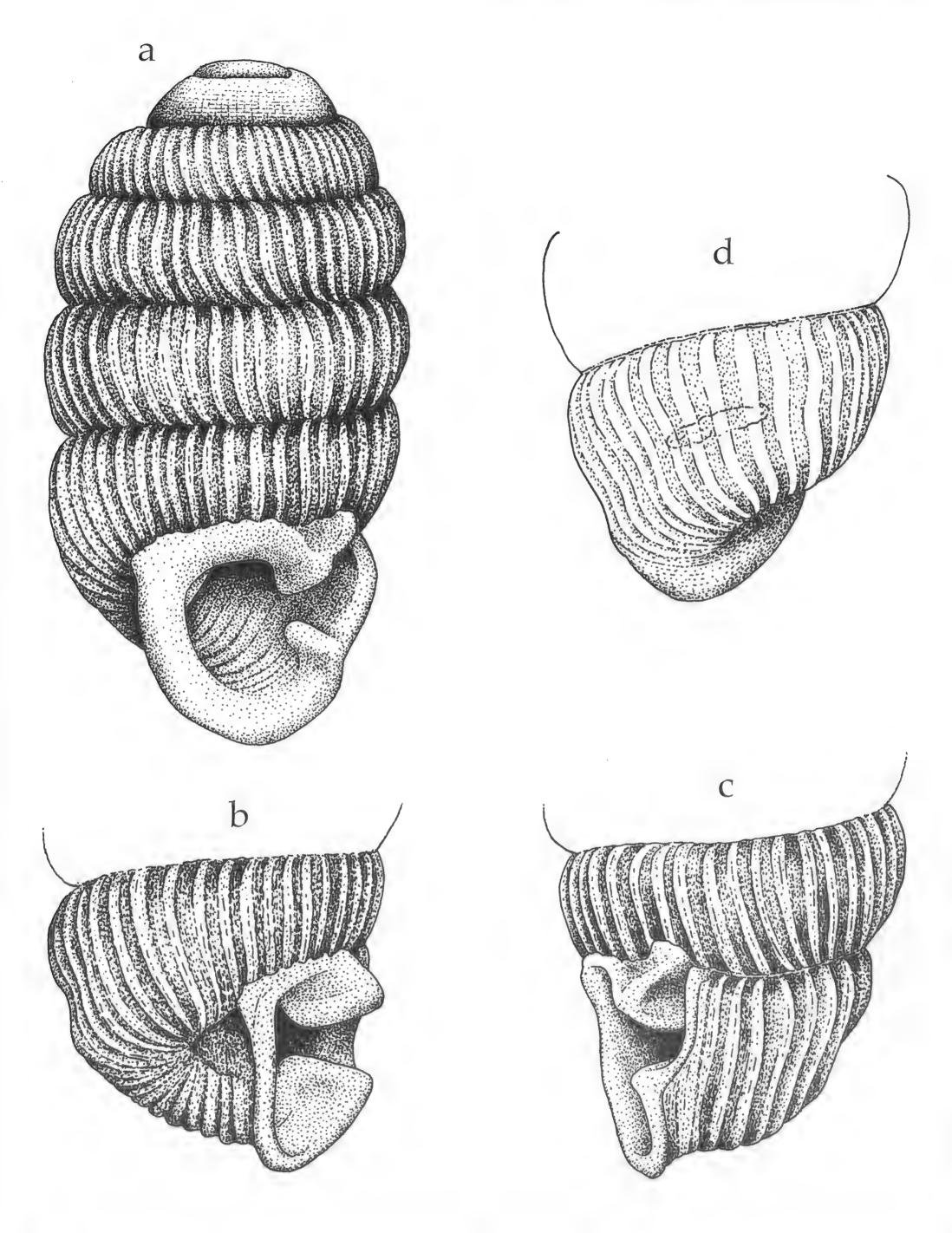
Shell Measurements (in mm) Holotype height 2.6 (paratype 2.5); diameter 1.4 (1.4); height last whorl 1.4 (1.3).

Description Shell minute, translucent-white, sub-cylindrical with 6.5 rather tumid and shouldered whorls (Fig. 1). Apex domed, the first 2½ smooth apart from very fine, regular spiral microsculpture. The remaining whorls all have very strong, regularly-spaced, rather shiny, blunt, radial ribs, the gap between the ribs being slightly greater than the width of the ribs themselves; there are about 20 ribs visible on the face of the body whorl.

The aperture is irregular heart-shaped. The peristome is thickened and reflected, and continuous across the parietal area. There are two rather stout, lamella-like denticles visible in the palatal and parietal regions, each extending for about 0.35 mm into the shell mouth from the peristome (Fig. 1b). The top of the columella is slightly thickened. The parieto-angular denticle is thickened at the peristome where it has a V-shaped cross section. The palatal denticle is located at mid-point on the palatal lip, from which it projects to form a point when viewed from the side; externally it is marked by a shallow depression. The palatal and angular denticles form a roughly oval sinus. The palatal part of the sinus is indented so as to form a distinctly concave outline when viewed from the side of the shell (Fig. 1c).

There is a third, elongated palatal spiral denticle, about 0.4 mm in length, set back in the mouth about ½ whorl from the aperture entrance. This denticle is not visible when viewed directly into the mouth of the shell but it can be seen in extreme oblique view, or through the shell when illuminated by transmitted light (Fig. 1d). Internally, it is not connected with the palatal denticle situated at the peristome. Externally, the spiral denticle is marked by a shallow spiral furrow. The external furrow continues very weakly towards the aperture, where it joins the depression that marks the position of the outer palatal denticle.

Although it is deeply set into the shell, the single spiral, upper palatal lamella and external furrow are sufficient to assign this new species to *Parennea* with confidence. The most distinctive characters of *mazumbaiense* are its strong, regular radial ribbing, the form of the sinus between the angular and palatal denticles, the concave profile of the upper palatal region of the peristome and the presence of the deeply set, elongated spiral palatal lamella which is not visible when viewed from the shell aperture.



**Fig. 1** Holotype of *Ptychotrema* (*Parennea*) *mazumbaiense* n. sp. **a** Shell **b** oblique view of aperture showing palatal and parietal denticles **c** side view showing concave sinus and protruding palatal denticle **d** view from back of body whorl showing position of elongated palatal lamella.

Derivation of name from the type locality, Mazumbai Forest.

Comparisons Van Bruggen's (1989) paper contains a tabular, 'Preliminary guide to the identification of the species of *Parennea*' which is based on shell height, shape (ratio of shell height/diameter), whorl number, sculpture and dentition. When considered in combination, the characters used in the guide allow the elimination from consideration of all save 6 of the 44 species and subspecies listed in van Bruggen (1989). These species are *cedrorum* Connolly, *elgonense* Adam & Van Goethem, *goossensi* Adam & Van Goethem, *kerereense* Adam & Van Goethem, *splendens* Adam & Van Goethem and *tshibindanum* Pilsbry & Cockerell. Holotypes of *kerereense* (RINSB PNV) *splendens* (RINSB PVA A1168) and *goosensis* (PNU 1114), and material of *cedrorum* collected from Mount Elgon,

Kenya has been examined.

These species are all known from locations that are geographically distant from the Usambaras. They can be separated from mazumbaiense as follows. The palatal lamella of cedrorum does not reach the peristome and the angular lamella enters much more deeply into the aperture; the ribbing on the shell of cedrorum is also much finer. Pt (P.) elgonense has a large columellar process which is absent from the species described here. Pt. (P.) goossensis shares the hidden palatal lamella found in mazumbaiense and in this respect is perhaps closest of all the species considered here; however, it is separable on other characters being smaller and with a more slender and cylindrical shaped shell, with a proportionately shallower suture. Also, it does not have a reflected peristome and its shell sculpture consists of extremely fine, irregular wavy ribbing, overlain by slightly stronger ribs. In kerereense the palatal fold is separate from the palatal denticle but the former is longer, being clearly visible in front view and extending for about 1 whorl into the shell mouth. Additionally, this species has a larger and more ovate shell with an apex which tapers to a distinct point; neither its shell sculpture nor its reflected lip is as strongly developed as in mazumbaiense. Pt. (P.) splendens is also larger, more ovate and has a tapering apex with fine radial sculpture on the first whorl and generally weaker and more finely spaced ribbing lower on the shell; the body whorl also tapers to the base, thus producing a more ovate shape than in either mazumbaiense or kerereense. The shell aperture of splendens is more rounded, especially across the basal section; although not as strongly developed; its palatal lamella extends more deeply into the shell mouth. Pt. (P.) tshibindanum has an open umbilicus, a stronger palatal fold and spiral microsculpture.

Two other species of *Parennea* are known from the general area - *usambarense* Verdcourt from the East and West Usambaras, and *sperabile* (Preston) from the Shimba Hills that lie about 120 km to the north-east of the Usambaras, near the south Kenyan coast. The species described here differs from these species in that the former is larger, has more whorls and a stronger and longer spiral palatal lamella which is clearly visible through the aperture. Verdcourt (1958) includes a drawing of Preston's *sperabile*, which has a smooth shell, a minute inset basal tooth and a second small inset palatal denticle

just below the main one.

#### **DISCUSSION**

The Usambara and other Eastern Arc mountains (Lovett, 1993) are famous for their high levels of endemism in many groups (Rodgers and Homewood, 1982). However, their biotas also have strong southern and western affinities; for example, many species of tree are shared with the central African, Guineo-Congolian forest (Lovett, 1993). Other species of central African gastropod, such as *Thapsia eucosmia* Pilsbry and *Gulella* 

handeiensis Verdcourt are known from the forests of the Usambaras and the presence of *Parennea* may also be indicative of such a link.

As discussed above, mazumbaiense is clearly a different species from usambarense and sperabile which are the other 2 Parennea known from north-east Tanzania/south-east Kenya. However, it is noteworthy that amongst the 43 species listed by van Bruggen (1989), it is only these 3 species (and possibly conicum Adam & Van Goethem) which share the distinctive, concave, upper palatal section of the peristome and protruding palatal denticle. A single shell in poor condition of a further, probably undescribed, species of Parennea was collected by the author from a forest at 480 m asl in the East Usambaras in 1995; it is intermediate in size between usambarense and mazumbaiense but shares the distinctive palatal margin. While there is insufficient evidence to be certain about the origin of the area's Parennea, this common character may provide evidence that the 3 (or 4) species concerned have resulted from local radiation rather than from several colonisation events by species from the west.

The small size of *Pt.* (*P.*) *mazumbaiense* account from it having been overlooked previously. Nevertheless, no other *Parennea* species (but see above) have been located during reasonably intensive fieldwork in other Tanzanian Eastern Arc mountain ranges using litter sieving methods (Tattersfield, unpublished). It seems likely that *mazumbaiense* is endemic to the Usambara mountains; at least 75% of the Usambaran species of the diverse streptaxid genus *Gulella* are endemic (Rodgers and Homewood, 1982).

#### **ACKNOWLEDGEMENTS**

I am indebted to Drs Bernard Verdcourt (Kew) and Graham Oliver (National Museum of Wales) for their advice and support. Dr Mary Seddon kindly compared *mazumbaiense* with type material on loan to the National Museum of Wales and made valuable suggestions. Mr Chris Meecham, National Museum of Wales drew the excellent illustrations. I thank Dr Jackie Van Goethem (Institut royal des Sciences naturelles de Belgique, Bruxelles, Belgium) for the loan of type material.

Zambia Habibu, Caroline Michael, Ismail Ally and many other Tanzanians helped me during fieldwork. I would also like to thank Mr Richard Mrecha of the Mazumbai Forest Station for local advice and Prof. Chamshama (Sokoine University of Agriculture, Morogoro) for permission to work in Mazumbai Forest.

The Tanzania Commission for Science and Technology granted permission to undertake the research in Tanzania. The local co-ordinator was Dr Peter Kasigwa, University of Dar es Salaam. In Tanzania, Dr Bill Newmark and Professor Kim Howell also provided me with advice and assistance.

Finally, I would like to thank the British Ecological Society, Linnean Society and the Peoples Trust for Endangered Species who generously supported the fieldwork.

#### REFERENCES

- Adam W. and Goethem J.L. Van 1978 Révision du sous-genre *Parennea* Pilsbry du genre *Ptychotrema* Mörch (Mollusca Pulmonata Streptaxidae) *Etudes du Continent Africain, Bruxelles* 5: 1–79.
- Bruggen A.C. van 1989 Studies on *Parennea* (Mollusca, Gastropoda, Streptaxidae) additional to the revision by Adam & Van Goethem, 1978 *Proceedings of the Koninklijke Nederlandse Akademie van Wetenschappen* Series C, **92** (1): 1–56.
- LOVETT J.C. 1993 Eastern Arc moist forest flora *In* (Lovett J.C. & Wasser S. eds) *Biogeography and Ecology of Rain Forests of East Africa* CUP, Cambridge, UK.

#### 34 P. Tattersfield

- Pilsbry H.A. 1919 A Review of the Land Mollusks of the Belgian Congo Chiefly Based on the Collections of the American Museum Congo Expedition, 1909–1915 Bulletin of the American Museum of Natural History XL (I): 1–370.
- REDHEAD J.F. 1981 The Mazumbai Forest: an island of lower montane rain forest in the west Usambaras *African Journal of Ecology* **19**: 195–199.
- Rodgers W.A. & Homewood K.M. 1982 Species richness and endemism in the Usambara mountain forests, Tanzania *Biological Journal of the Linnean Society* **18**: 197–242.
- VERDCOURT B. 1958 A new species of *Ptychotrema* Mörch (Mollusca: Gastropoda) from Tanganyika together with a check list of the East African species and keys for their determination *Journal of the Linnean Society, London, Zoology* **43**: 714–720.
- VERDCOURT B. 1961 Further notes on the genus *Ptychotrema* Mörch in eastern Africa (Mollusca, Streptaxidae) *Archiv fur Molluskenkunde* **90**: 155–161.
- VERDCOURT B. 1983 A list of the non-marine Mollusca of East Africa (Kenya, Uganda, Tanzania, excluding Lake Malawi) *Achatina* **11**: 200–239.

# ON TWO ANDALUSIAN *OESTOPHORA* SPECIES: *OESTOPHORA ORTIZI* DE WINTER & RIPKEN, 1991 AND *OESTOPHORA GRANESAE SPEC. NOV.* (GASTROPODA: PULMONATA)

#### J.R. Arrébola Burgos<sup>1</sup>

Abstract Anatomical features and new distribution records of Oestophora ortizi De Winter & Ripken are presented and Oestophora granesae spec. nov. is described from Andalusia (S of Iberian Peninsula). Although the new species is classified in the genus Oestophora, the anatomical study has shown some peculiar differences with respect to all other Oestophora species: the presence of a small penial papilla and the similar length of the penis and the epiphallus. These differences have been assumed as a new anatomical variability pattern in the genus.

Key words Gastropoda, Oestophora, O. ortizi, O. granesae spec. nov., S of Spain,

#### Introduction

Oestophora Hesse, 1907 comprises several species living in the Iberian Peninsula, north Africa and the Azores Islands. This genus, which initially grouped all the related species known up to that date, was later divided into three subgenera by Ortiz de Zárate & Ortiz de Zárate (1961) and Ortiz de Zárate (1962): Oestophora s. str. and the two new subgenera Suboestophora Ortiz de Zárate, 1962 and Gasullia Ortiz de Zárate, 1962. In 1986, Prieto raised the three subgenera to genera rank.

The genus *Oestophora* comprises about 10 species, most of them presenting in the Iberian Peninsula: *O. lusitanica* (Pfeiffer, 1841), *O. barbula* (Rossmässler, 1838), *O. silvae* Ortiz de Zárate, 1962, *O. tarnieri* (Morelet, 1854), *O. dorotheae* Hesse, 1930, *O. calpeana* (Morelet, 1854) and *O. ortizi* De Winter & Ripken, 1991. All these species display a similar shell morphology and genitalia characterised mainly by the absence of a penial papilla and flagellum, a penis much longer than the epiphallus, three wavy mucous glands attached to the vaginal walls and a dart-sac complex with a small, rounded and externally hardly visible dart-sac, internally connected with a larger, cylindrical, muscular and elongated accessory sac (Nordsieck, 1993; Puente, 1994b; Arrébola, 1995).

It must be remembered, however, that De Winter & Ripken (1991) described *O. ortizi* from conchological characters and on a small group of anatomical features ("The penis is relatively wide and short, without a flagellum. Dart sac muscular and glossy, elongate cylindrical in shape. Mucus glands appear to originate next to the swollen basal part of the bursal duct") only just enough to include the species in *Oestophora* genus. From the morphological data available, Puente (1994b and 1996) named respectively as *Oestophora* cf. *ortizi* and *Oestophora* ortizi "in strictest confidence" some specimens collected in the NE of Cadiz, not very far from the type locality in Malaga province ("just W of Torremolinos, from rock crevice in dry calcareous slope" - UF65). This author added a complete anatomical description of the specimens.

The aim of the present work is to complete the knowledge of the genus *Oestophora* in the Iberian Peninsula, confirming and amplifying the data contributed by De Winter and Ripken (1991) and Puente (1994a, 1994b, 1996) for the least-known species: *O. ortizi* De Winter and Ripken, 1991, and the description of a new species, *O. granesae* spec. nov., whose inclusion in *Oestophora* means the modification of the generic diagnosis regarding certain anatomical features.

<sup>&</sup>lt;sup>1</sup> Departamento de Fisiología y Biología Animal, Facultad de Biología, Universidad de Sevilla, Avda. Reina Mercedes, 6. E 41012 - Sevilla, Spain.

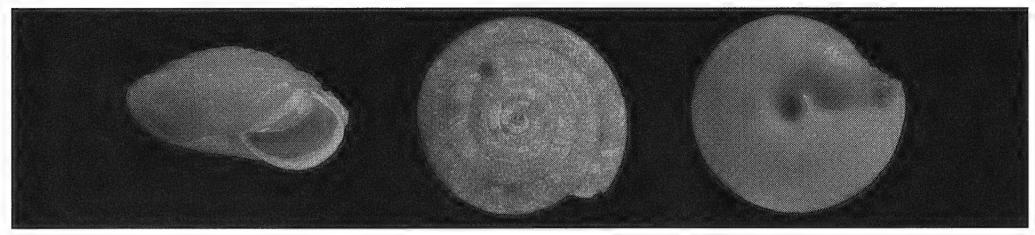
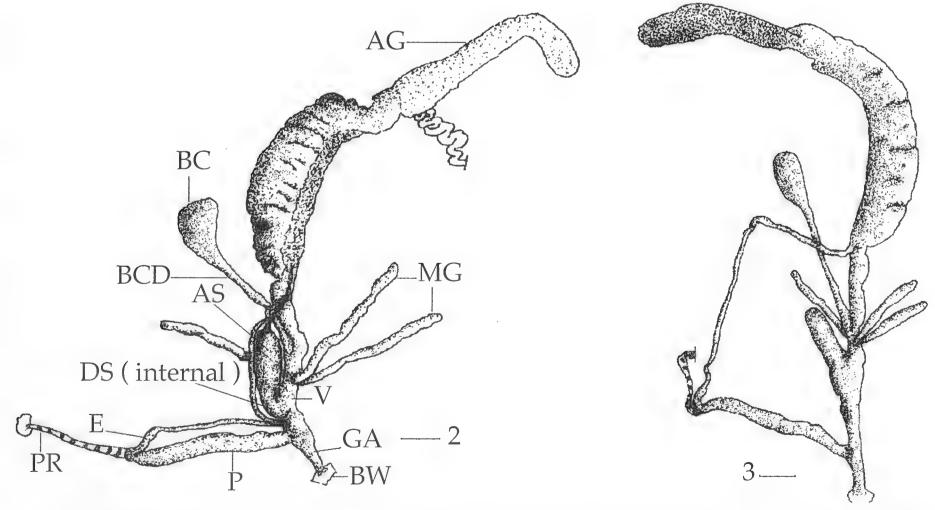


Fig. 1 Shell of Oestophora ortizi

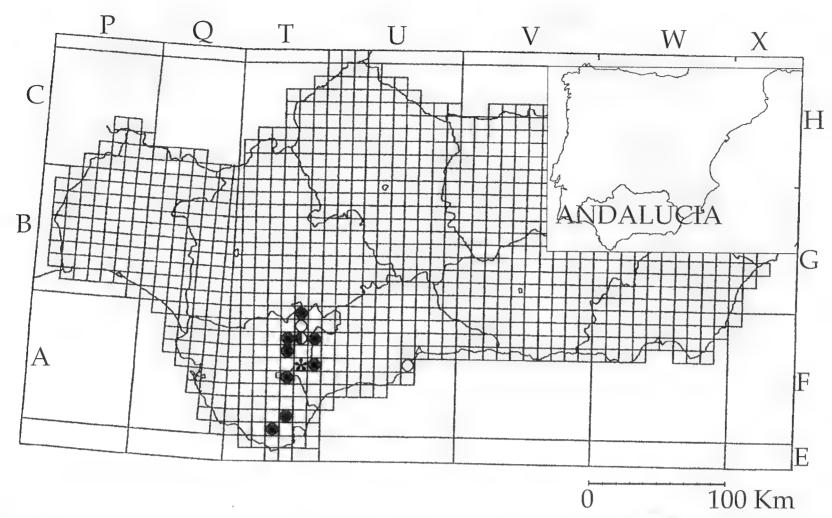
Oestophora ortizi De Winter & Ripken, 1991
Figs 1–3

*Material* **Seville** Coripe, 12.01.91, 30STF7297, 200-400 m (1s). **Cadiz** Cortijo de Ahojiz, road 440 to Los Barrios, 05.02.90, 30STF7010, 0-200 m (8a + 2s). Almodovar reservoir, 05.02.90, 30STF6104, 0-200 m (6a). Algar-Jimena de la Frontera road: Pasada Blanca stream, 16.02.91, 30STF7442, 0-200 m (1a + 7s). Zahara: Arroyomolinos, 22.04.91, 30STF8878, 0-200 m (1a). El Bosque, 30.05.91, 30STF7871, 0-200 m (5s). El Bosque, 30.05.91, 30STF7669, 0-200 m (1a + 2s). Benamahoma: fish farm, 31.10.91, 30STF8071, 600-800 m (1s). 6 km Grazalema-Ronda road, 01.11.91, 30STF9271, 800-1000 m (3a + 1s). **Malaga** Estación de Cortes de la Frontera-Opayar road (River Guadiaro), 01.11.91, 30STF8878, 0-200 m (1a). El Bosque, 30.05.91, 30STF7871, 0-200 m (5s). El Bosque, 30.05.91, 30STF76. (The material studied is now in the collection of the author). (J.R. Arrébola leg.) (a = animal; s = shell).

Description Shell circular, depressed and convex in both sides. Medium solid and uniform pale brown in colour, although something more clear below. Umbilicus round, cylindrical, deep and ½ of the shell diameter. Very slightly raised spire of 5 to 6 slow and regularly increasing whorls separated by deep sutures. Last whorl rounded or vaguely angulated at the periphery and not descending in front. Protoconch with 1½



**Figs. 2–3** Genital system of *Oestophora ortizi*. **1** 6 km Grazalema-Ronda road (Cadiz, TF9271). **2** Cortijo de Ahojiz, road 440 to Los Barrios (Cadiz, TF7010). **AG** albumen gland **BC** bursa copulatrix **BCD** bursa copulatrix duct **BW** body wall E epiphallus **GA** genital atrium **MG** mucous glands **P** penis **PR** penial retractor **V** vagina. Scale = 1 mm.



**Map 1** Geographical distribution in Andalusia of *Oestophora ortizi* (● new localities; O localities cited in the literature) and *Oestophora granesae* spec. nov. (★), in UTM notation of 10 x 10 km squares.

to 1½ smooth whorls. The aperture is semilunar, wider than tall. Peristome somewhat reflected in all extension, specially below. Periostracal surface of the teleoconch patterned by fine, regular and close ribs which are slightly visible on the ventral side of the shell.

Genital system Right ommatophore retractor muscle between penis and vagina. Atrium longer than wide. Penis long, cylindrical, uniform in width and covered by a penial sheath. The inner surface of the penial walls shows several pleats. There is no penial papilla and the penial retractor insertion indicates the distal end of the penis. Epiphallus much shorter than penis and elbow-shaped. There is no flagellum and the epiphallus-vas deferens transition is evident. The vas deferens is long and thin. Dart-sac complex with a long and large accessory sac flowing into the small and usually not externally visible dart sac. The accessory sac shows glossy, thick and muscular walls, is practically totally free from the vagina and its upper end is connected to the spermoviduct by a muscular ligament. There are three long mucous glands connected to the vagina on opposite sides (2:1). The bursa copulatrix is small, variable in shape and with a slender duct somewhat shorter than the penis. Free oviduct long.

Measurements Maximum diameter: 8.0–9.1 mm; height: 4.3–4.6 mm.

Distribution O. ortizi is an Andalusian endemic known only from the southernmost part of Seville province, the west of Cadiz province and Malaga province. See map 1.

*Ecology* The species has been found between 0 and 1000 m altitude, the most common range being 0–500 m. The animals live mainly under stones in areas that are damp, shady, mountainous or not, and uncultivated, with rich vegetation.

#### **COMMENTARIES AND DISCUSSION**

A study of the samples collected in numerous sites of Cadiz province leads to the conclusion that there are specimens that can be identified only as *O. ortizi* De Winter & Ripken. In fact, the features of these specimens agree with those given by De Winter & Ripken (1991) and Puente (1994b, 1996), and characterise this species with respect to all other *Oestophora* species (Arrébola, 1995). In particular, the species most similar to *O. ortizi* is *O. tarnieri* (Morelet, 1854), from which *O. ortizi* can be distinguished by its presenting a shorter spire, a non-angular periphery, cylindrical umbilicus (perspective in *O. tarnieri*) (De Winter & Ripken, 1991), one whorl fewer (on average), a wider and more vertical aperture of smaller size (Arrébola, 1995). The new data widen the geographical distribution of *O. ortizi* to a strip comprising part of the southern sector of Seville province, the eastern part of Cadiz province, and the western half of Malaga province.

### *Oestophora granesae* spec. nov. Figs 4–7

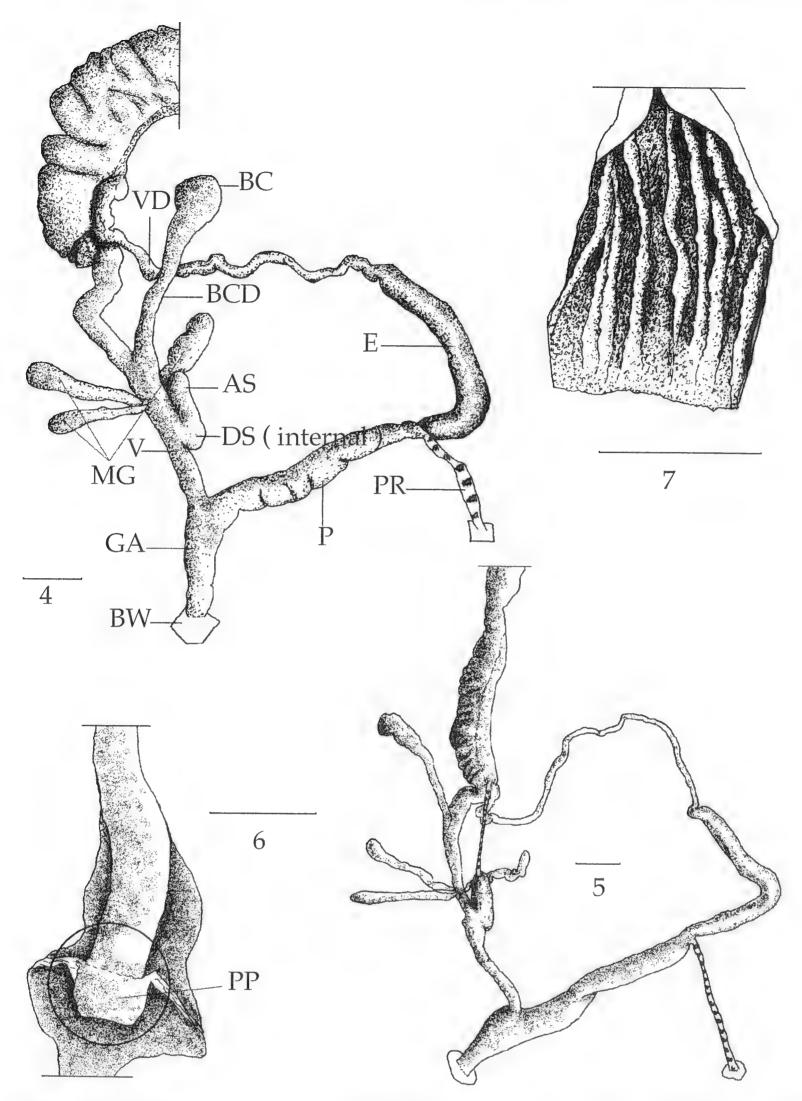
*Holotype* 1s Ubrique-Gaucín road, 3 km before Loma del Castillo (Malaga), 02.11.91, 30STF8252, 600-800 m, C. Granés leg. (Registered in the Museo de Ciencias Naturales de Madrid, 15.05/23762)

Paratypes Same data as holotype (1a + 1s). Type locality: J. Arrébola leg., 28.05.94, (7a). See map 1. (a = animal; s = shell).

*Diagnosis* O. granesae has a shell with an almost cylindrical umbilicus, and genitalia characterized by the presence of a small penial papilla and an epiphallus as long as or longer than the penis.

Description Shell small, medium solid and slightly translucent. Colour varying from yellowish to pale-brown. Circular and depressed in shape with similar convex sides. Umbilicus rounded, almost cylindrical, deep and approximately ½ of the maximum shell width. Spire of 5½–6 arched whorls growing slowly and regularly, separated by deep sutures; the last whorl angulated at the periphery and not descending at the aperture. Protoconch with 1¾ whorls. Aperture flattened, elliptical and without barriers and internal rib. Peristome interrupted and somewhat reflected and thickened in its whole area, although only slightly in the upper part. Periostracal surface of the teleoconch patterned by fine, regular, patent ribs, much less conspicuous on the ventral side; they are closer in the first whorls and more separated with the growth of the shell.

Genital system Genital atrium comparatively long (1.6–1.8 mm) and thick (0.5–0.8 mm). Penis (3.9–4.5 mm) as long as, or a little shorter than, the epiphallus (4.1–4.8 mm) and with a similar width throughout its length, though it may become slighty slimmer towards the distal part. It is enveloped by a thin sheath where the penis retractor muscle joins. Internal part of the penis with a very short penial papilla (0.5 mm in length) and several longitudinal pleats. The penial papilla is a constant structure which can nevertheless be regarded as an extroreflection of the epiphallus into the penis. Epiphallus cylindrical, uniform in width (0.5 mm), with thick muscular walls and glossy appearance. There is no flagellum. Vas deferens short and thin throughout its length, except in the proximal part where it becomes much thicker. Vagina narrower than the atrium and variable in length. Stimulatory apparatus with accessory sac, dart sac placed at the base of the former, and three mucous glands. Accessory sac much longer and wider than the dart sac, with thick muscular wall, glossy appearance and with about ½–½ of its total



**Figs 4–7** Genital system of *Oestophora granesae* spec. nov. (5–6) Penial papilla. Ubrique Gaucin road: 3 km before Loma del Castillo (Malaga). **AS** Accessory sac **BC** bursa copulatrix **BCD** bursa copulatrix duct **BW** body wall **DS** dart sac **E** epiphallus **GA** genital atrium **MG** mucous glands **P** penial papilla **PR** penial retractor **V** vagina **VD** vas deferens. Scale = 1 mm.

length joined to the vagina wall. Dart sac very small and not externally visible; it contains a minute, straight, wedge-shaped dart. A muscular band originates from the spermoviduct, runs along the long free oviduct and the proximal part of the vagina, and ends attached to the free end of the accessory sac. Mucous glands rather short and wide or fairly wide; they join to the vagina on opposite sides (2:1). Bursa copulatrix small, variable in shape, with a short relatively wide duct.

Measurements Maximum diameter 4.3–4.5 mm; height 8.5–9.0 mm.

#### TABLE 1

Differences between *Oestophora granesae* spec. nov. and the genera *Suboestophora* Ortiz de Zárate and *Gasullia* Ortiz de Zárate

Shell:	Oestophora granesae Peristome is somewhat reflected and the umbilicus is small and almost cylindrical	Suboestophora Peristome is not reflected and the umbilicus is much wider	Gasullia Open umbilicus
	No flagellum; more than half the total length of the accessory sac is separated from the vaginal wall; the three mucous glands are inserted in the vagina	Flagellum present; accessory sac is completely attached to the vagina; the two mucous glands have, respectively, two and three extremities	Flagellum present; epiphallus usually much shorter than the penis; insertion of the two mucous glands takes place in accessory sac

*Ecology* The specimens were collected about 15–20 m from a creek, under various big stones belonging to the ruins of a small house, in an uncultivated area with poor vegetation. Altitude between 600 and 800 m. The type locality is in a well-preserved site belonging to the Natural Park "Los Alcornocales" (Cadiz and Malaga provinces).

Derivation of name The name granesae is dedicated to Carmen Granes, who discovered the first specimen of the new species.

#### **COMMENTARIES AND DISCUSSION**

The new species is clearly distinguished by the features of its genital tract from species belonging to the closer genera *Gasullia* Ortiz de Zárate and *Suboestophora* Ortiz de Zárate (see Table 1) to which it could be referred by the existence of some anatomical characters in common: the presence of a penial papilla (both genera) and the similar length shown by the penis and the epiphallus (especially in *Gasullia*). However, keeping in mind the rest of the characters described (shell included), and especially the absence of flagellum and the stimulatory apparatus structure, the new species would appear to belong to the genus *Oestophora* (see Prieto 1986, Nordsieck 1993, Puente 1994b, Arrébola 1995).

Nevertheless, the two underlined anatomical features also seem to distinguish the new species from all other *Oestophora*. Certainly, after Ortiz de Zárate & Ortiz de Zárate (1961) divided the genus *Oestophora* Hesse into three subgenera subsequently raised to genera level by Prieto (1986), this pattern has never been included in the descriptions of the genus (Ortiz de Zárate 1962, Gittenberger 1968, Castillejo 1984, Aparicio 1986, Nordsieck 1987, Schileyko 1991, Muñoz & Parejo 1992, Puente, 1996).

Because of the present lack of data on some *Oestophora* species, especially the N African ones (Hesse, 1918), which restricts knowledge of the shell and genital tract variability in the genus, the erection of a new generic or subgeneric name is not warranted. On the other hand, according to the latest discussion about the great importance of the stimulatory apparatus structure in the systematics of these (and other) genera (Nordsieck 1987, 1993, Giusti & Manganelli 1988, Schileyko 1991, Puente 1994b), the new species must be included in *Oestophora*, which means a change of its description: "pres-

ence of a penial papilla" and "epiphallus variable in external appearance" must be included.

The discovery of a new species of *Oestophora* in the southern part of the Iberian Peninsula, and its anatomical features, reinforce the notion of Puente (1996) that the Peninsula is a probable centre of origin and diversification of the genus, and even of the subfamily to which it belongs (Trissexodontinae Nordsieck, 1987 according to the author).

#### REFERENCES

- APARICIO M.T. 1986 Consideraciones sobre el valor taxonómico de los caracteres utilizados en la determinacion de las especies de la familia Helicidae de España peninsular *Iberus* 6: 131–140.
- Arrébola J.R. 1995 Caracoles terrestres (Gastropoda, Stylommatophora) de Andalusia, con especial referencia a las provincias de Sevilla y Cadiz. Tesis Doctoral. Universidad de Sevilla. 589 pp + 16 lám.
- Castillejo J. 1984 Caracoles terrestres de Galicia, I. Género *Oestophora* Hésse, 1907. (Pulmonata, Helicidae) *Iberus* 4: 125–133.
- DE WINTER A.J. & RIPKEN E.J. 1991 New land snails (Gastropoda Pulmonata) from the Iberian peninsula *Basteria* 55: 3–7.
- GITTENBERGER E. 1968 Zur systematik der in die gattung Trissexodon Pilsbry (Helicidae, Helicodantinae) gerechneten Zoölogische Mededelingen 43 (13) 165–173.
- GIUSTI F. & MANGANELLI G. 1988 Montserratina Ortiz de Zárate López, 1946 (Pulmonata, Hygromiidae): A redescription *Iberus* 8 (1): 89–100.
- HESSE P. 1918 Die Subfamilie Helicodontinae Nachrichtsblatt der Deutschen Malakozoologishen Gesellschaft 50: 99–110.
- Muñoz B. & Parejo C. 1992 Redescription of *Suboestophora gasulli* nov. comb. for *Oestophora (Gasullia) gasulli* (Gastropoda: Pulmonata) *Journal of Conchology* **34**: 205–213.
- NORDSIECK H. 1987 Revision des Systems der Helicoidea (Gastropoda, Stylommatophora) *Archiv für Molluskenkunde* **118** (1/3): 9–50.
- Nordsieck H. 1993 Das System der paläarktischen Hygromiidae (Gastropoda: Pulmonata: Helicoidea) *Archiv für Molluskenkunde* 122: 1–23.
- Ortiz de Zárate A. 1962 Observaciones anatómicas y posición sistemática de varios helícidos españoles. V. Género *Oestophora* Hesse, 1907 *Boletin de la Real Sociedad Española de Historia Natural*. *Madrid* (*Biol.*) **60**: 81–104.
- Ortiz de Zárate A. & Ortiz de Zárate A. 1961 Moluscos terrestres recogidos en la provincia de Huelva Boletin de la Real Sociedad Española de Historia Natural. Madrid (Biol.) 59: 169–196.
- Prieto C.E. 1986. Estudio sistemático y biogeográfico de los Helicidae sensu Zilch. 1959-60 (Gastropoda: Pulmonata: Stylommatophora) del País Vasco y regiones adyacentes Tesis Doctoral. Universidad del País Vasco 393 pp. + 10 lám.
- PUENTE 1994a Lista preliminar de las especies de Helicoidea (Pulmonata: Stylommatophora) del cuadrante suroccidental de la Península Ibérica Cuaderni dell'Academia Internazionale biologia (Bilbao) 18:11-19.
- Puente 1994b Estudio taxonómico y biogeográfico de la Superfamilia Helicoidea Rafinesque. 1815 (Gastropoda: Pulmonata: Stylommatophora) de la Península Ibérica e Islas Baleares Tesis doctoral. Universidad del Pais Vasco 970 pp. + CXCII lám.
- PUENTE 1996 El género *Oestophora* Hesse 1907 en la *Península Ibérica* (Gastropoda: Pulmonata: Hygromiidae: Trissexodontinae *Archiv für Molluskenkunde* **126** (1/2): 81–107.
- Schleyko A.A. 1991 Taxonomic status, phylogenetic relations and system of the Helicoidea sensu lato (Pulmonata) *Archiv für Molluskenkunde* **120** (4/6): 187–236.



## OBSERVATIONS ON EXTENSIVE, DENSE POPULATIONS OF THE BIVALVE MOLLUSC MUSCULUS DISCORS (L., 1758)

Extensive, very dense populations of the bivalve mollusc *Musculus discors* (L., 1758) were recorded at a number of shallow, subtidal sites while SCUBA diving around the island of Papa Westray, northwest Orkney. Commonly used identification handbooks suggest that this widespread species is normally found as scattered individuals nestling among rocks and algae<sup>1</sup>. However, in this case it was found dominating large areas of seabed in the infralittoral zone. Such an occurrence may be rare and was considered worthy of note.

The observations were made during a survey of the feeding grounds of the Black Guillemot or Tystie (*Cepphus grylle* (L.)) carried out by members of the Marine Conservation Society on behalf of the Applied Ornithology Unit, University of Glasgow between 14–18 July 1997. All survey sites were within the 30 m depth contour around Papa Westray (59° 21′N 2° 51′W) and not further than about 1.5 km from the shore.

At certain sites within the survey area, the seabed in the infralittoral kelp zone (at depths of less than 20 m below chart datum) was smothered by populations of *Musculus discors* together with scattered individuals of the edible mussel, *Mytilus edulis* (L.). This dense cover of *M. discors* extended over the seabed for the duration of the dive at the sites where the species was recorded (distances of 100 m or so). At one location the proportions of the two species were roughly 3:1 *Musculus:Mytilus.* Upward facing rocky surfaces (Fig. 1), kelp holdfasts and the lower part of kelp stipes were entirely covered with individual *Musculus* up to 5 mm in length. The sites with the most dense populations to the north and east of the island were all subject to moderately accelerated tidal streams at certain times of the tidal cycle (observations made during the survey) (Fig. 2). Individual *Musculus* formed a mat up to 25 mm thick covering every horizontal

**Fig. 1** A dense population of the mytilid *Musculus discors* on subtidal bedrock in the infralittoral zone on Papa Westray, Orkney. Scale bar = 10 mm.

#### TABLE 1

Conspicuous fauna and flora together with abundance recorded in association with dense populations of the mytilid *Musculus discors* in the infralittoral zone on Papa Westray, Orkney.

#### **FAUNA**

Sagartia elegans (O)
Sagartia troglodytes (O)
Urticina feline (O)
Cancer pagurus (O)
Galathea squamifera (O)
Necora puber (O)
Calliostoma zizyphinum (O)
Gibbula cineraria (O)
Nucella lapillus (O)

44

Musculus discors (SA)
Mytilus edulis (C)
Asterias rubens (O)
Henricia sp. (O)
Ophiura (O)
Diplosoma spongiforme (O)
Lissoclinum perforatum (F)
Morchelium argus (O)
Sidnyum turbinatum (F)

#### **FLORA**

Calophyllis laciniata (O)
Encrusting coralline algae (C)
?Kallymenia reniformis (O)
Nitophyllum punctum (O)

Odonthalia dentate (C)
Phycodrys rubens (O)
Plocamium cartilagineum (F)
Laminaria hyperborea (A)

#### Abundance scale:

SA super abundant, A abundant, C common, F frequent, O occasional, ? identification uncertain.

surface over many square metres of seabed. Estimates of population densities based on photographic records give numbers of up to 22,000 individuals per square meter. Small individuals of *M. discors* were also seen attached to Velvet Swimming Crabs (*Necora puber*). On the basis of the list of conspicuous associated fauna and flora (Table 1) this infralittoral biotope on Papa Westray, in the absence of *M. discors*, would have been classified as *Laminaria hyperborea* forest, foliose red seaweeds and a diverse fauna on tideswept infralittoral rock<sup>2</sup>.

Divers surveying deeper locations (>20 m below chart datum) in stronger tidal streams did not record dense populations of *Musculus*, the dominant mytilid at these sites being the Horse Mussel, *Modiolus modiolus* (L.) (Mark Woombs pers. comm.).

The subtidal biotope manual recently produced by the Marine Nature Conservation Review team of the Joint Nature Conservation Committee<sup>2</sup> includes one biotope dominated by *M. discors: Musculus discors* beds on moderately exposed circalittoral rock (i.e. below the kelp zone). This biotope has been reported from Wales: North Pembrokeshire<sup>3</sup>, North Lleyn<sup>4</sup> and Anglesey<sup>2</sup>; as well as Ireland: Glandore Bay in south Cork and Rathlin O'Birne, an island off the coast of Donegal<sup>2</sup>. The habitat classification describes the biotope as occurring in full strength seawater, in the circalittoral on bedrock and boulders exposed to moderate wave action and weak to moderately strong tidal streams<sup>2</sup>.

Associated fauna at all the above sites included a variety of sponges, hydroids and bryozoans typical of the open coast of the area concerned, though Cartlidge & Hiscock³ considered that dense mat of *Musculus* had a smothering effect on other fauna and flora. Hiscock⁴ observed that the Common Starfish (*Asterias rubens*) was common on areas dominated by *Mytilus edulis* but only occasionally on *Musculus* areas. As would be expected the associated fauna and flora reported during the present survey is typical of the infralittoral kelp zone, rather than the circalittoral of the earlier studies.

Hiscock<sup>4</sup> concluded that the community was of regional conservation importance off the Northwest Lleyn Peninsula based on its rarity of occurrence, although its likely tran-



**Fig. 2** Study Location Map. • sites where *Musculus discors* was recorded; O sites where the species was not recorded; --- low water mark; --- 20 m contour.

sitory reduce the significance<sup>3</sup>. Connor *et al.*<sup>2</sup> have recorded the biotope as being uncommon within the British Isles. Beds of *M. discors* have also been reported from the French Channel coast including off Roscoff in depths of 20–45 m<sup>5</sup> and east of Cap de la Hague<sup>6</sup> in areas with strong water movement. In addition, a similar association has been described from other sites in Ireland: Kilkieran Bay, Co. Galway<sup>7</sup> and Carnsore Point, Co. Wexford (Konnecker pers. comm.), both locations with accelerated tidal streams.

The present observation of *M. discors* extends the distribution of dense populations much further north in Europe (Orkney) than previous reports, in addition to providing records from infralittoral zone within the kelp forest. This raises the question: Are these dense populations of *Musculus discors* more widely distributed than would appear to be the case up until now, for example Scandinavia and Iceland?

The diving survey was funded in part by Scottish Natural Heritage, the Joint Nature Conservation Committee and the Applied Ornithology Unit, University of Glasgow for which we are most grateful. Special thanks are due to Tom Sawyer and David Trimble for so much logistical support.

<sup>&</sup>lt;sup>1</sup> Tebble N. 1966 British Bivalve Seashells. A Handbook for Identification The British Museum (Natural History) London 212 pp.

<sup>&</sup>lt;sup>2</sup> Connor D.W., Dalkin M.J., Hill T.O., Holt R.H.F. & Sanderson W.G. 1997 Marine Nature Conservation Review: Marine Biotope Classification for Britain and Ireland. Volume 2. Sublittoral Biotopes Version 97.06. JNCC Report No.230.

<sup>&</sup>lt;sup>3</sup> CARTLIDGE D. & HISCOCK K. 1980 South West Britain Sub-littoral Survey: Field Survey of Sublittoral Habitats and Species in North Pembrokeshire Nature Conservancy Council, CSD Report No. 295, 57 pp.

<sup>&</sup>lt;sup>4</sup>HISCOCK K. 1984 Sublittoral Survey of Bardsey and the Lleyn Peninsula Nature Conservancy Council,

CSD Report No. 612, 60 pp.

- <sup>5</sup>CABIOCH L. 1968 Cahiers de Biologie Marine 5 (suppl.) 493–720.
- <sup>6</sup>Retiere C. 1979 Contribution à la Connaissance des Peuplements Benthiques du Golf Normanno-Breton Thesis, University of Rennes.
- <sup>7</sup>Konnecker G.F. & Keegan B.F. 1983 Proceedings of the Royal Irish Academy 83 (B) 309–324.

B.M. Baldock J.M. Mallinson D.R. Seaward c/o River Laboratory Department of Oceanography Barn Court University of Southampton East Stoke Hamlet Wareham Southampton Oceanography Centre Chetnole Dorset BH20 6BB Sherborne European Way Dorset DT9 6NY Southampton SO14 3ZH

## THE DISTRIBUTION OF *PSEUDOGLESSULA TERRULENTA* (MORELET, 1883) (PULMONATA: SUBULINIDAE) IN TROPICAL AFRICA

Three collections made by Frontier Tanzania during 1995-1996 in north-east Tanzania contained a small species of *Pseudoglessula* which matched nothing I had previously seen from the area, although I recognised it was very close to *P. stuhlmanni* (von Mts) widespread in Uganda and Zaire. Many years ago I noted that this seemed scarcely distinct from *Bulimus terrulentus* Morelet and later discovered that Connolly¹ had published exactly this conclusion and transferred the species to *Pseudoglessula*. He pointed out that Pilsbry had wrongly placed it in *Curvella* due to the fact that he had not seen Morelet's

type which had been rather poorly figured.

These are evergreen forest species quite different in their habitat from the rather similar small species related to P. ingloria Connolly which are rather dry woodland species (Verdcourt²). One rather curious feature of the rain forest species is a minute moirée pattern covering the interstices between the ribs and also producing very fine striae on the ribs themselves. A study of all the material in The Natural History Museum has led me to believe that terrulenta, stuhlmanni and the Tanzanian material actually belong to a single species with isolated populations differing considerably in dimensions but, at present, without adequate material to determine if they comprise genuine subspecies. Many forest species in all groups share similar distributions. The Tanzanian material ranges in size  $7.5-8.2 \times 3.5-4$  mm whereas Pilsbry³ gives the dimensions of P. stuhlmanni as  $9-12.4 \times 4.5-5.8$  mm. Material from Angola described as P. delicatula Preston is  $9.5 \times 4$  mm. The type material of P . terrulenta described from Gabon is terrulenta terrul

The synonymy and distribution of this species, for which Morelet's epithet is by far the earliest, is set out below.

Pseudoglessula terrulenta (Morelet)

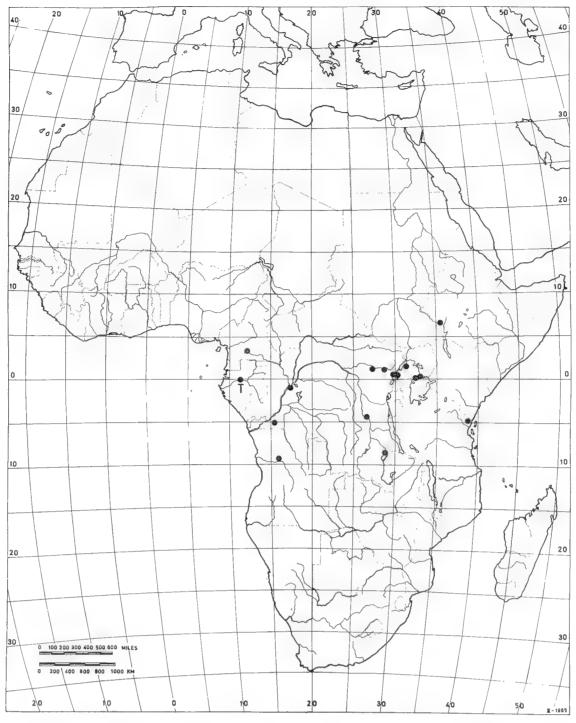
Bulimus terrulentus Morelet in Journal de Conchyliologie 31: 398, pl.10, Fig. 3 (1883).

Buliminus stuhlmanni Von Martens in Sitzungsberichte der Gesellschaft Naturforschender Freunde zu Berlin 1895: 128 (1895) and Beschalte Weichthiere Deutsch-Ost-Afrikas: 63, pl.3, Figs 26, 29 (1897).

Curvella terrulenta (Morelet); Pilsbry, Manual of Conchology, Series 2, **18**: 52, pl.9, Figs 42, 43 (1906) and in Bulletin American Museum of Natural History **40**: 153, Fig. 57 (1919). Cerastus delicatula (sic) Preston in Proceedings Malacological Society London **9**: 53, Fig.

(1910).

Pseudoglessula terrulenta (Morelet); Connolly in Annals and Magazine of Natural History,



Distribution of Pseudoglessula terrulenta (Morelet)

#### Series 9, 11: 351 (1923).

Pseudoglessula stuhlmanni (Von Martens); Thiele in Sitzungsberichte der Gesellschaft Naturforschender Freunde zu Berlin 1933: 308 (1933) Bacci in Annali del Museo Civico di Storia Naturale di Genova 65: 68 (1951); Verdcourt in Archiv für Molluskenkunde 96: 55, Fig. 38 (1967).

#### Distribution

Cameroon, Gabon, Zaire, Ethiopia, Uganda, Tanzania, and Angola. CAMEROON. Bitye (= Bitze, Bitya, Bitje), Bates (BM, 1937.12.30.8065-8072, proposed type material for a 'new species' Preston meant to describe) and without locality but probably from same lot (BM 1913.2.27.32-36). GABON. R. Ogowé (Ogooue), Lope (BM, 1893.2.4.1150-1152, syntypes) (I am not sure where this locality is exactly, the U.S. Gazeteer refers to a stream of that name at 0°.04'S, 11°.34'E, Mary Kingsley mentions a mountain and N. Hallé's gazeteer<sup>5</sup> gives no such locality). ZAIRE. Semliki Valley: W. Ruwenzori, Karevia; Bukende, Bugundi (Orani) and Ongenya, Stuhlmann (ZMB 101892, lectotype of stuhlmanni; ZMB 101893 paralectotypes, Karewia (only locality cited in Von Martens original description) see Kilias and Kilias' Ituri Forest: Avakubi; Penge, Lang & Chapin (AMNH). Semliki Forest, Moho, near Lesse, Lang & Chapin (AMNH). Kisantu, Lukolela, Vieux Kassongo, Lukonsolwa and Beni, Bequaert (AMNH). ETHIOPIA. Kefa, Gimiro, ?Sciacco to Guraferda, Neumann (ZMB) Thiele<sup>7</sup> gave the locality as 'Oberen Gelo (Scheko - Gurafarda) which Bacci transcribes as 'Alto corso del Ghila'. Mt Guraferda is at 6°N 55'E and must be approximately correct; Scheko could be Sciacco. I saw this specimen about 40 years ago and apparently had no cause to doubt its identity). UGANDA. Bunyoro District: Bugoma, Pitman (Liverpool). Toro District: Bwamba Valley, G.D.H. Carpenter (NMK); Bwamba Forest, Salisbury Coll. (Liverpool). Mengo

District: Entebbe, G.D.H. Carpenter (NMK) and Pitman (Liverpool); Damba I., G.G.H. Carpenter (NMK); Mabira Forest, Salisbury Coll. (Liverpool) Munyonyo (Manyonyo, Manyonjo), Stuhlmann (ZMB; BM 1893.3.22.19–20; 1902.5.26.18–19). TANZANIA. Muheza District: Usambara foothills, Kwamgumi/Segoma Forest Reserve, 4°57′S 38°43′E, K.M. Harris, Frontier Tanzania (BM); Marimba Forest Reserve, 5°01′S 38°43′E, Frontier Tanzania, comm. J. Bayliss (NMW.Z), Kwamgumi Forest Reserve, 4°57′S 38°44′E, plot 1/iii, Frontier Tanzania (BM) (total of 8 specimens). Mtai Forest Reserve, 4°51′S, 38°46′ E, MT 73, plot II, Frontier Tanzania (BM). ANGOLA. 320 km. E. of Loanda (if directly East this would be near Mola about 80 km N of Malange although it is very likely the latter is the locality meant), Ansorge (MRAC, lectotype of *delicatula*; BM, 1909.12.18.7–12 & 1989030, paralectotypes).

- <sup>1</sup> CONNOLLY M. 1923 Annals and Magazine of Natural History, Series 9 11: 351.
- <sup>2</sup> VERDCOURT B. 1967 Archiv für Molluskenkunde 96: 43–6, Figs 1–39.
- <sup>3</sup> Pilsbry H.A. 1919 Bulletin American Museum of Natural History 40: 153.
- <sup>4</sup> KINGSLEY M. 1897 Travels in West Africa MacMillan, London.
- <sup>5</sup> HALLE N. 1964 Flore du Gabon 8: 220–228.
- <sup>6</sup> Kilias R. & Kilias I. 1982 Mitteilungen aus dem Zoologischen Museum in Berlin 58: 379.
- <sup>7</sup> Thiele J. 1933 Sitzungsberichte der Gesellschaft Naturforschender Freunde zu Berlin **1933**: 308.

B. Verdcourt
Royal Botanic Gardens
Kew
Richmond
Surrey
TW9 3AB

#### GULELLA SPINOSA (TATTERSFIELD, 1998), NEW TO KENYA

Gulella spinosa (Tattersfield, 1998) was recently described from western Mt Kilimanjaro, NE Tanzania, where it was found in degraded forest on the lower slopes at around 1310 m above sea level¹. Since its formal description, this species has also been recorded from the Taita Hills (3°25′S, 38° 20′E) in the Taveta district of Kenya, which lies some 140 km to the east of the type locality. Being composed of old, crystalline rocks of the Mozambique Series, the Taita Hills are geologically quite dissimilar to Kilimanjaro which consists of relatively recent volcanic deposits.

The Kenyan records provide further information on the ecology of the species. The species was present in the two largest indigenous forest fragments of Taita (Mbololo & Ngangao) where the common indigenous tree species include *Albizia gummifera*, *Chrysophyllum gorungosanum*, *Macaranga conglomerayta* and *Ocotea usambarensis* (East

African camphor). The latter species has been exploited in these forests.

Gulella spinosa was most common in Mbololo which is the largest and the most intact forest fragment still remaining in the Taita Hills. It was found in dense, moist forest-floor litter, as at the type locality, but was associated with relatively flat sites dominated by huge mature trees, with a high, relatively intact canopy (60–80% canopy cover) and few signs of disturbance. Most specimens were collected below the surface cover of forest floor litter in the zone where there is a homogeneous mixture of soil and plant debris. They were also frequent at the bottom of large tree trunks (e.g. Ocotea usambarensis). At around 2200 m altitude, these sites are substantially higher than the type locality on Kilimanjaro.

The Taita Hills form the northern massif of the ancient Eastern Arc chain of mountains that extend from south-east Kenya, through eastern Tanzania to the Malawi border. Like most of the other Eastern Arc ranges, the Taitas are known to support several endemic and range-restricted species in other groups, although their forests are now highly depleted. Both of these new sites for *G. spinosa* are either already gazetted or proposed as Forest Reserves. Recent (as yet unpublished) mollusc surveys in the Usambara and Pare Mountains in north-east Tanzania, which are the closest Eastern Arc ranges to the Taitas, have failed to locate *G. spinosa* despite the use of intensive sieving methods.

Charles N. Lange, Mary B. Seddon & Peter Tattersfield
Department of Biodiversity & Systematic Biology
National Museum of Wales
Cathays Park
Cardiff
CF1 3NP

<sup>&</sup>lt;sup>1</sup> Tattersfield P. 1998 Journal of Conchology 36 (2): 31–41.

#### A DISCOVERY OF TRUNCATELLA SUBCYLINDRICA LIVING IN CORNWALL

In October 1998, a specimen of *Truncatella subcylindrica* was found in the St Mawes Bay area of the Fal estuary, Cornwall. This represents the first confirmed living record in the county and considerably extends the current known range of extant populations in

southern England.

The looping snail *Truncatella subcylindrica* (L., 1758) (Prosobranchia: Hydrobiidae) has a geographical distribution which reaches its northern limit in Britain. It is one of a group of molluscs which are considered to be part of the crevice faunas of that tidal zone which forms the interface of intertidal animals of terrestrial origin and those which are truly marine. The animals inhabiting the uppermost region of the intertidal zone of a shore are often very small, cryptic and are subjected to ephemeral and extreme conditions imposed by both the diurnal and monthly tidal regimes. *T. subcylindrica* lives in muddy places at the level of high tide where it may be only occasionally inundated by sea water. It is associated with fully saline conditions and commonly associated with the plants *Suaeda maritima* and *S. fruticosa* (sea blites) and *Halimione portulacoides* (sea purslane). Where it is to be found living interstitially in shingle, it is usually found at about 15 cm depth amongst rotting saltmarsh vegetation and moist fine sediment. At other sites it can be found living between unmortared but firmly embedded slabs which form sea walls. The animals are found amongst the mud and detritus infilling the joints between the slabs.

Truncatella subcylindrica is a southern species occurring mainly in the Mediterranean, on Madeira and Azores and extends north to the Channel coasts of France and southern England. It was formerly known from 12 sites in Britain ranging from Porthcurno on the Land's End Peninsula along the south coast of England and extending as far as the Deben and Orwell estuaries in Suffolk. However, few of these records refer to living populations. Although there is some evidence that *T. subcylindrica* is in decline at the northern limit of its range, searching for the species requires detailed examination of its cryptic habitat. Such sites and habitats are often overlooked by conchologists and marine biologists alike, and although *T. subcylindrica* is rare, it may well be under-recorded. Living populations were known from six localities: the species' stronghold is the Fleet in Dorset where it lives in very large numbers interstitially at high water mark on the landward side of the shingle bank. The others are all in the Solent area: Warsash in the Humble estuary, Pagham Harbour, Eastney/Langstone Harbour, and Freshwater Gate and King's Quay on the Isle of Wight.

Previous records for *T. subcylindrica* in Cornwall are few and all appear to be based on dead shells recovered from strandline deposits. It was first recorded by Dr William Pennington Cocks before 1849 from sites in the Falmouth area: Harbour and Bar Point, and Gyllyngvase Bay. The latter site is on the open Channel coast, outside the Fal estuary system, from where the shells are presumed to be derived. There are two records for Porthcurno, one pre-1900, but the other as recent as 1976 by Alan Seccombe. The provenance of these specimens is an enigma because the cove does not appear to provide habitat that is suitable for *T. subcylindrica*. The only other Cornish record is based on a single fresh shell found in 1965 by Stella Turk by the sea wall in Fowey harbour.

This latest Cornish discovery is based on a single, living adult specimen which was attached to a large slab of rock embedded in fine muddy shingle at high water mark. The site lies in the estuary of the Percuil River which flows into St Mawes Bay. The size and extent of the population is unknown, but as suitable habitat is patchy and discontinuous no other large slabs were turned thus avoiding further disturbance. The only

other mollusc species directly associated with the *Truncatella* was *Ovatella myosotis*, although *Leucophytia bidentata* occurred slightly lower down the shore.

Truncatella subcylindrica is listed as category RDB2 Rare in the British Red Data Book and is also listed in the Joint Nature Conservation Committee Rare Species Directory. The habitat occurs in places which may be subject to development proposals, particularly from the marine leisure industry and populations at most known British sites are small and localised. Lacking an aquatic dispersal phase during development, the species might be vulnerable to loss of habitat since its powers of recolonisation are assumed to be poor and fragmentation of its habitat would be detrimental. It is not known how sensitive the species might be to pollution.

The site for this newly discovered Cornish population lies within a candidate Special Area of Conservation (cSAC). Although this will afford the site and species a certain level of protection, the population is vulnerable owing to its apparently small size and extent of occupied area. St Mawes Bay is very popular as a mooring area for yachts and small craft and, therefore, a particular threat could arise from removal of upper shore slabs to create hearths for beach fires or barbeques.

We are grateful to Stella Turk for providing information on local habitats and for details of historical records of *T. subcylindrica* in Cornwall.

Ian Killeen
Malacological Services
163 High Road West
Felixstowe
Suffolk
IP11 9BD

e-mail: ian@malacserv.demon.co.uk

Janice Light
Dept of Geology
Royal Holloway University of London
Egham
Surrey
TW20 OEX

e- mail: jan@aquamar.demon.co.uk

#### **REVIEWS**

Structura izmenchivosti vidov na primere nazemnykh molliuskov ("Species variability structure exemplified by the land snails") by I.M. Khokhutkin, Ekaterinburg: Ural Branch, 1997, pp. 175.

This is a shortish review, in Russian, of interspecific and intraspecific variability and adaptation resulting from natural selection and various environmental effects, taking as an example the land snails, principally the Eurasian *Bradybaena fruticum* and related species. Special attention is paid to climatic, environmental, and other ecological factors, and their effects upon shell size and fertility etc., and shell colour variation in relation with vegetation. Parallel evolution, linkage and supergenes, and the evolution of dominance in the 6 species of *Bradybaena* found on either side of the Urals, is also dealt with in considerable detail. And there is quite a good account of the large amount of work done on other snails, particularly on shell colour and banding patterns in the polymorphic *Cepaea* species, mostly by non-Russians.

This is preceded by a general discussion of evolutionary and other problems in species adaptation, including population numbers and density, reproduction and life

cycles, and the age structure of natural populations.

There is a useful and up-to-date bibliography of about 150 items in Russian, few of which will be familiar to workers elsewhere, and rather more than that of non-Russian work, mostly in English.

C.B. Goodhart

Mollusca: The Southern Synthesis. Fauna of Australia Vol 5, by P.L. Beesley, G.J.B. Ross and A. Wells (eds) CSIRO Publishing: Melbourne, 1998. Part A i–xvi, 1–563, Part B i–viii, 565–1234. ISBN 0 643 0576 0. Available from: CSIRO PUBLISHING, PO Box 1139 (150 Oxford Street), Collingwood, VIC 3066, Australia. Phone (61+3) 96627666; fax (61+3) 96627555; e-mail: sales@publish.csiro.au. Price: \$A295 plus \$A8 postage and packing for purchasers in Australia and New Zealand; \$US295 plus \$US8 postage and packing elsewhere.

This beautiful book is a comprehensive and authoritative overview of the state of knowledge of the Mollusca of Australia. It is a compilation of contributions, in the form of whole or parts of chapters, from 70 authors of high standing in their subjects and from many countries, mainly but not wholly from the English speaking world. The scale of this undertaking is reflected not only in the need to publish this volume in two parts but also, sadly, by the decease of 5 of the contributors, among them Vera Fretter, Tom

Thompson and Alan Solem prior to publication.

Part A covers an overview of the Phylum Mollusca, and the Classes Aplacophora, Polyplacophora, Bivalvia, Scaphopoda, and Cephalopoda. Part B is concerned solely with the Gastropoda. The scope of the overview is all inclusive. Starting with a definition and general description, it covers not only classification but also the history of discovery of Australian Mollusca, their morphology and physiology, molluscan life histories, ecology (molluscs on rocky shores, coral reefs, marine and estuarine sediments, pelagic molluscs, molluscs on land and in inland waters), economic significance for good and bad, distribution and biogeographic relationships, the fossil record, methods of study and conservation. This last section is particularly welcome, coming as it does when the conservation of Mollusca deserves a higher profile within the general need to conserve biodiversity as a whole.

For the rest of the book each major division generally follows the same plan as the overview from definition and general description through to ecology and related topics (grouped as natural history), then descending levels of classification in each class, down to family level. The layout of the book appears to have been arranged for ease of access rather than to adhere faithfully to the classification adopted (in, for instance, figures 1.4 and 14.1). This is particularly noticeable in the Gastropoda, where the chapter headings - "Prosobranchs", "Opisthobranchia", and "Pulmonata", all not further qualified, derive from the "traditional "classification.

The book is outstanding in terms of presentation; the vast majority of pages have one or more black and white text figures or photographs; nearly all of these are of very high quality, though the contrast between background and subject could have been better in one or two photographs, like Figures 1.61 and 1.70. There is a colour photograph frontispiece, and there are 37 superb colour plates, mostly with 5 or 6 figures each, inter-

leaving the pages before chapter 1 and grouped in the centre of each part.

At each level from Phylum down to Family there is a summary of current knowledge and key works, using information from outside the Australian fauna where necessary. A word of caution here; the preface says (:v), of illustrations, that these are based on Australian material unless indicated otherwise; this will not always be immediately obvious to readers not familiar with the Australian or extra-Australian faunas and the literature cited; see for example Figure 4.22. Different views and interpretations are included, with sources cited throughout. A bibliography is given at the end of each chapter, the "flier" claiming citation of 7700 papers in the primary literature. There is a useful glossary at the end of Part B, as well as a unified index which covers both the various levels of taxa and the subjects (including, for example, pioneer malacologists) referred to in the text. A particularly welcome feature is the listing of all taxa above genus level for certain selected subjects such as diversity, endemism (in Australia) and the fossil record.

An immense amount of information is given concisely and readably and users should have no difficulty in understanding it or finding out where to go for further detail. Given the number of contributing authors the uniformity of presentation is outstanding even though, inevitably, there are bound to be slight unevenness of treatment, and occasional minor errors. An example of the first is the minimal reference to the fossil record in the Pholadoidea and a relatively full treatment of that for the Nautiloidea. For examples of the second, the reference to *Histoire Animaux sans Vertébrés* on page 7 should read *Histoire Naturelle des Animaux sans Vertèbres* and the first P initial in the index entry for Lamarck should be a B; the specific name in the caption *Nanamoria strophon* for Figure 1.101 C should be *strophodon* [from *Voluta strophodon* McCoy, 1876]; Figure 14.18 D not C is after Solem 1974 [see *The Shell Makers*: 179 Figure 5 (b)] and I was puzzled by the paragraph on Conidae on page 854 which includes "The oldest Australian fossils are Oligocene ...... Three Australian Eocene species extend into the Miocene ......" But this is by way of minor disappointment rather than serious criticism.

I do not know of any recent book on Mollusca which covers so much ground and is relevant not only in the specific region covered but also worldwide except perhaps for cold regions. It will be indispensable as work of reference for many years and is a great credit to all who contributed to its making. All institutions in any way concerned with malacology, or the fauna of Australia, should acquire it, and individuals should not be put off by the price when you consider it is over 1200 packed pages; I wasn't, and I am

proud to have a copy.

# CONCHOLOGICAL SOCIETY OF GREAT BRITAIN & IRELAND

# REPORT OF THE COUNCIL 1997-1998

The Society announced with regret the death of one member, Mr Roger Tallack, member since 1989.

#### Council Positions

Mr Brian Eversham was elected President of the Society. New Ordinary Members of Council for 1997/8 were Mr Aldridge, Mrs Platts and Dr Bishop. Mr Killeen, Mrs Weideli and Ms Chesney began their second year on Council; Mr Boyce, Mr Pinn and Mrs Street began their final year on Council. Ms Trew was co-opted to Council so that she could familiarise herself with the post of Treasurer. All other Council positions remained unchanged.

#### **Publications**

The first edition of the new format *Journal of Conchology* (Volume **36**, Part 1) was published in December 1997 and distributed to members in January 1998. Five issues of the *Conchologists' Newsletter* were published (Volume **8**, Part 2, Number 140 and Volume **8**, Part 3, Numbers 141–144 and Index). The Society also published the Annual Programme Card and revised Membership List and mail order form in January 1998.

#### Other Council Matters

Five Council meetings were held in 1997/8, and there were two meetings of the Publications Committee, the Journal of Conchology being regularly discussed throughout the year. The Publications Committee also reported on issues concerning the Special Publication No. 2. Proceedings of the Molluscan Conservation Conference and the possible introduction of a series of publications to replace Papers for Students. The Special Publication is due for imminent publication; the new Papers for Students is under discussion. Council also discussed many other issues. These included issues relating to possible changes to the Society's rules, which are to be voted on at this Annual General Meeting; the arrangements for and funding of the second Malacological Pioneers joint meeting, which was held in November at the Linnean Society in London; the formation of a Conservation Committee for which purpose a working party was set up and the analysis of the members' questionnaire circulated in January 1997 (results to be published shortly). Council approved the production of a CD-ROM Marine Atlas, and voted on a ban on smoking at all indoor meetings. Members of the Council, in particular the Marine Recorder, liaised with the Marine Conservation Society in the production of a report on the sale of shells from Marine Arts Shells in Sainsbury's Homebase stores. The environmental implications of this product were misrepresented on the labelling and Sainsbury's withdrew the product.

The Society's Display Boards were used at Reading, Haslemere, Surrey Heath (Camberley) and Brighton. Part of the display was also used at a meeting on distribution mapping held in the Pyrenees, where Mrs Light and Mr Killeen were also able to sell Society merchandise.

J.E. Reynolds Hon. General Secretary

# Treasurers Report 1997 (Subject to Audit)

Income exceeded expenditure by £7,361. Of this £2,433 related to income from the Molluscan Conservation Conference. A special publication of the proceedings from this conference is in course of preparation and a provision has been made in the accounts to cover this. Allowing for this and for the transfer of £750 to the Research and Reserve fund profit for the year is £3,131.

Income from subscription was £11,405 which is slightly less than in the previous year. This is due to a small loss in the number of subscribers which is of no immediate concern

as the numbers fluctuate slightly each year.

Sales of back numbers of the publications and other goods have once again proved a useful source of income, but now that most members have purchased the items they

require, sales income is declining.

The costs of publishing and distributing the Society's publications have reduced, mainly due to the reduced cost of printing the latest *Journal of Conchology*. An accrual of £4,000 has been made to cover the printing of *Journal* Vol. 36, Part 2 which had not been printed by the end of the year. The cost of producing the *Newsletter* has remained stable.

The life membership reserve has been calculated in accordance with the principles

used last year and the fund remains at £2,990 (26 life members at £115 each).

At the year end the cumulative cost of the investments, the earliest of which were made in 1967, was £32,258. The market value of these investments at 31 December 1997 was £69,369. Investments are shown in this balance sheet at market value and this policy will be continued in the future. Investments comprise, Unit Trusts £31,629, National savings Bonds £10,000, Government Stocks £10,090, Corporate Loan Stock £2,340 and Equities £15,310.

At the end of the accounting year membership of the society stood at 376. This includes 43 institutes. Overall 22 new members were recruited in 1997. This offsets the loss resulting from resignations and lapsed subscriptions, giving a net increase of 2 personal members and 2 institutional members.

In summary, the society continues to be in a good financial position, and there is no need to consider a rise in the subscription rates.

M.D. Weideli Hon. Treasurer

Hon. Auditors

# CONCHOLOGICAL SOCIETY OF GREAT BRITAIN & IRELAND. ACCOUNTS FOR THE YEAR ENDED 31 DECEMBER 1997

# INCOME AND EXPENDITURE ACCOUNT

	31 Dec. 1997 £	31 Dec. 1996 £	
Income Fees and Subscriptions Investment Income Sales & Donations Special Events Income	11,405.12 2,920.09 2,231.91 2,433.44	12,184 2,937 1,902 0	
TT 10.	18,990.56	17,023	
Expenditure Publication Costs Stationery & Sundry Postage Meetings Sundry Costs	9,236.48 746.10 900.00 746.60	10,413 1,022 729 1,114	
Emana of Imagene Orrer	11,629.18	13,278	
Excess of Income Over Expenditure	7,361.38	3,745	
Transfer to Research & Reserve	(750.00)	(718)	
Transfer from Life Membership Transfer to other reserve	(3,480.00)	230 (400)	
Profit/Loss for Year	3,131.38 ======	2,857 ====	
	Balance Sheet		
	31 Dec. 1997 £	31 Dec. 1996 £	
Assets Investment (Market Value) Cash Debtors	69,369.00 18,729.97 260.17	32,258 8,687 209	(At Cost)
Tieleilities	88,359.14	41,154	
Liabilities Creditors and Accrued Charges Advance Subscription Life Members Fund Reserve & Research Fund Other Reserves	$\begin{array}{r} 6,868.36 \\ 460.96 \\ 2,990.00 \\ 45,921.51 \\ 4,664.25 \\ \hline 60,905.08 \end{array}$	4,022 575 2,990 8,061 1,184 16,832	
Net Current Assets	27,454.06	24,322	
		,	
Represented by: Capital Account brought fwd. Profit/(Loss) for year	24,322.68 3,131.38	21,465 2,857	
	27,454.06	24,322	
M.D. Weideli Hon. Treasurer			N. Light D. Worth

### PROGRAMME SECRETARY'S REPORT - MARCH 1998

The 1997 programme comprised 5 indoor meetings held at the Natural History Museum in London, a joint conference held at the Linnean Society in London, 6 field meetings and 3 workshops.

Lectures at indoor meetings were given by Rupert Honnor ("Rocky Shores of the World: Molluscan Similarities"), Richard Preece (Presidential address: "Mapping Snails in Time"), David Reid (Natural History Museum: "Evolution of Littorina: Wonderful Winkles!"), Peter Morden (Natural History Museum: "Land Molluscs of the Azores"), and Kevin Brown ("What's in a Name?")

A very successful joint meeting was held with the Malacological Society of London, the Society for the History of Natural History, and the Linnean Society of London, entitled "Gentlemen and Players: Professionals and Amateurs in Malacology, 1900–1950", at the Linnean Society, Burlington House, Piccadilly, London. The conference was organised largely by Elizabeth Platts, and the speakers were as follows: David Allen (Wellcome Institute: "On Parallel Lines: Natural History and Biology in the Post-Victorian Era"), Graham Oliver (National Museum of Wales: "Passion to Elitism; or Conchology to Malacology"), Nick Evans (Natural History Museum: "An Appreciation of A.E. Boycott and H.E. Quick"), Ian Killeen ("Mapping Britain's Snail Fauna - The Years 1900 to 1950"), Bryan Clarke (University of Nottingham: "John T. Gulick and the Evolution of Island Snails"), James Murray (University of Virginia: "Henry Edward Crampton and Mendelian Evolution"), Laurence Cook (University of Manchester: "Varieties, Forms and Freaks of Nature: Breeding Experiments by Charles Oldham and A.W. Stelfox"), Robert Cameron (University of Sheffield: "Cepea Research 1900 - 1950: Too Many Problems for a Solution"), Brian Morton (University of Hong Kong: "C.M. Yonge: Mr. Bivalve ... "), and John Messenger (University of Sheffield: "J.Z. Young: Doyen of Teuthologists").

Field meetings continue to be well attended, and were held at the following venues: Hampstead Heath, London (Leader: Jane Reynolds), West of Plymouth, Cornwall (Leader: Rupert Honnor), Arun Valley, near Pulborough, West Sussex (Leader: Martin Willing), the North Wales coast (Leaders: Tom Clifton), the Reading area, Berkshire (Leader: June Chatfield), and Blockley Quarry, Gloucestershire (Leader: David Long).

A workshop on British Slugs, tutored by Stella Davies was held at Judith Nelson's home in Woking. A workshop on exotic limpets, tutored by June Chatfield was held at the Reading Museum. The Society's twelfth Molluscan workshop was again held at the home of Judith Nelson in Woking. All of these events were great successes again.

The Society is grateful to all of those people who have contributed to the above programme, as speakers, field meeting leaders, and meeting and workshop organisers and tutors.

R. Honnor Hon. Programme Secretary

#### 59

## RECORDER'S REPORT: NON-MARINE MOLLUSCA

#### A Non-marine Atlas

Members will be aware that the new national distribution *Atlas*, in preparation for several years now, has been seriously delayed. I apologise to those many contributors who await the results of their labours with such patience. I am glad to report that the problems have been overcome and that the *Atlas of Land and Freshwater Molluscs of Britain and Ireland* should appear during the present year (1998), published by Harley Books of Colchester on behalf of the Conchological Society. Some grant-in-aid was received from the Royal Society. As in 1976 the maps have been generated at the Biological Records Centre at Monks Wood (Institute of Terrestrial Ecology). Unlike the 1976 edition the book consists not merely of maps, but includes a substantial introductory text, explanatory notes on the distribution patterns, and a bibliography. The estimated publication price is £25 (hardback) but there will be a special discount for members.

# **B** Vice-county records

The following new vice-comital records have been verified from voucher material since the last annual Report (*Journal of Conchology*, 1998, Volume 36, part 2, p 73). The collection date in all cases was 1997, unless stated otherwise.

Dorset (9): Pisidium pseudosphaerium, Wareham (30/9288), M.J. Willing.

Hants North (12): Ferrissia wautieri, Basingstoke Canal, Fleet (41/8153), I.J. Killeen.

Norfolk East (27): Pisidium pseudosphaerium, Burgh Common (63/4311), I.J. Killeen.

Norfolk West (28): Pisidium pseudosphaerium, Thompson Common (52/9396), I.J. Killeen.

Gloucester East (33): *Hygromia cinctella*, Leckhampton (32/9420; garden), D.C. Long. Caernarvon (49): *Vertigo geyeri*, Cors Geirch SSSI (23/3235), A.P. Fowles, 1996.

Lincoln North (54): Limax maculatus, Sturton (43/8980); Lehmannia valentiana, Gainsborough (43/8191, garden), both C. du Feu.

Nottingham (56): Lehmannia valentiana, Beckingham (43/7790); garden), C. du Feu.

Lancaster South (59): Lehmannia valentiana, Scotland Road, Liverpool (33/3491; waste ground), C. Felton.

York North-east (62): Vertigo alpestris, Helmsley (44/5983), A.A. Wardhaugh.

**Westmorland** (69): *Limax maculatus*, Natland, Kendal (34/5289; garden), B. Colville and N.A. Robinson.

**Wigtown** (74): *Planorbis carinatus, Anisus vortex,* Dunskey House Loch, Portpatrick (25/0056); *Planorbarius corneus,* Mull of Galloway (25/1431), all T. Huxley.

Perth Mid (88): Vertigo alpestris, Lochan na Leathain, Blair Atholl (27/8361), R.C. Preece.

Perth East (89): Hippeutis complanatus, Monk Myre (37/2042), T. Huxley.

Main Argyll (98): Anisus vortex, Loch Balnagowan, Lismore (17/8542), T. Huxley.

**Kintyre** (101): *Physa fontinalis*, Crosshill Loch, Campbeltown (16/7119); *Lymnaea stagnalis*, *Planorbis carinatus*, *Anisus vortex*, Mill Loch, Gigha (16/6450); *Anisus leucostoma*, Achamore Gardens, Gigha (16/6447), all T. Huxley.

Shetland (112): Limax cinereoniger, Kurkigarthe, Voe (HU3963), J. Darlington, 1974 (Royal

Scottish Museum).

Tipperary North (H10): Dreissena polymorpha, R. Shannon, Birdhill (11/6767), D. Minchin.

Now that general patterns of distribution within the British Isles are, for the most part, well known, the focus of recording has in the past few years shifted somewhat away from area mapping to a concentration on particular habitat types, especially those known or likely to contain rare species, or under threat of destruction. This change of emphasis has been reflected in recent Recorder's Reports.

The present year is no exception. Yet another site for *Vertigo geyeri* has been found, in a calcareous mossy fen with *Schoenus nigricans* on the mainland of North Wales, comple-

menting its occurrence at two similar sites on Anglesey. The population at Cors Geirch is seemingly quite small. Studies of marsh drains in Dorset and in Norfolk have turned up *Pisidium pseudosphaerium* in three new vice-counties. This very local bivalve evidently often occurs in profusion in the same swampy ditches which harbour *Segmentina nitida* and other declining aquatics.

Though not new vice-comital records, it is pleasant to note the rediscovery through such intensive campaigns of *Segmentina nitida* in North Somerset (v.c. 6) by Mrs Pat Hill-Cottingham (marsh drain at Catcott; 31/4041), and of *Valvata macrostoma* in a drainage ditch by the R. Avon at Sopley in South Hampshire (v.c. 11; 40/1497) by Martin Willing.

I am indebted to Thomas Huxley for much valuable freshwater recording in Scotland, mostly from small eutrophic water bodies of a kind rare in that country. This has resulted in the discovery of several isolated sites for what are essentially 'English' lowland species, like *Lymnaea stagnalis*, *Planorbis carinatus* and *Anisus vortex*; the finding of the last on the limestone island of Lismore (Argyllshire) is of particular interest, as it has eluded earlier naturalists studying the remarkable lochs there.

Dreissena polymorpha, known in England since the 1820s, has suddenly appeared in Ireland. Its introduction is likely to have taken place through Limerick Docks. Dreissena has quickly spread up the River Shannon and is now common in Lough Derg; its dispersal is undoubtedly being faciliated by pleasure craft, to which Dreissena attaches itself. There are fears that the ecology of Lough Derg may be permanently altered, as has happened in the Great Lakes in North America. The specimens seen by the Recorder (taken from an intake pipe at a fish hatchery) were from North Tipperary (v.c. H10) but the species has been noted from all vice-counties bordering the Shannon, between Limerick City (H8) and the north end of Lough Derg (H15), nearly 40 miles upstream. There is a recent report also of the species establishing itself in the R. Erne in Co. Fermanagh.

Vertigo alpestris was found on limestone rocks near Blair Atholl (Perthshire) and on a dry stone wall near Helmsley in North Yorkshire, both noteworthy discoveries - the latter considerably extending the known range of this species eastwards away from its strongholds in the southern lake District.

Among introduced terrestrial species, the 'greenhouse slug' *Lehmannia valentiana* has been verified from disturbed open habitats in three further vice-counties. Doubtless it remains still under-recorded. *Limax maculatus*, which is also likely to be an introduction to the British Isles but probably of longer standing, has been found in Lincolnshire and Westmorland. Lastly, the alien helicid *Hygromia cinctella* has been reported from yet another vice-county, from a garden in East Gloucestershire. The unusual mildness of recent winters has probably favoured the rapid spread of this attractive Mediterranean species, first noted at Paignton (Devon) in 1950.

M.P. Kerney

#### MARINE RECORDER'S REPORT - MARCH 1998

The past year has seen a continuation of the Society's marine field activities focused towards current mapping schemes: a week-long meeting west of Plymouth for the DOMMIC Project and a weekend trip in North Wales for the S23 Atlas. A notable sighting at Plymouth (reported in *Conchologists' Newsletter* No. 143) was the finding of a colony of *Onchidella celtica* at Whitsand Bay where it was located on the shady side of a steep rock at about mid-tide level. The colony appears to have been extremely localised

- similar rocks searched in the vicinity did not yield additional specimens. *Onchidella celtica* was also seen in a similar habitat in April 1997, again on one isolated rock outcrop at mid-tide level, further west at Portholland during my own fieldwork. This colony has long been known at this site (S.M. Turk) as has the Whitsand Bay colony. Although there are many records for this species from Cornwall there are only scattered records from elsewhere in the south and west of the British Isles and it is not known why the Cornish coasts represent such a stronghold.

As part of her project to map the marine molluscs of Ireland (and produce an Atlas for the year 2000), Julia Nunn reports that 82% of the 260 littoral squares which constitute the Irish coast have been visited either by herself, or by Shelagh Smith. She expects the remaining stretches of coast to be visited during 1998. This is no light undertaking! Notable records for 1997 are a single live specimen of the pyramidellid *Folinella excavata* from Lough Hyne, Co. Clare - the first post-1950 live record for the British Isles, and a specimen of the orange form of the nudibranch *Aeolidiella alderi* on Inishbofin, Connemara - confirming Lemche's earlier published record from a few miles away.

Alan Skene, Area Representative for S3, has sent me a copy of his report to the Orkney Field Club in which he lists a number of new shell records to the area as a result of work carried out by Christine Street. In Wales a startling find was made amongst some mytilids from scrapings from the walls of Roath Basin, Cardiff Docks, S. Wales by Andrew Mackie of National Museum of Wales in Cardiff. Distinguished by the presence of a thick, lamellar periostracum, some of the mussels were identified as *Mytilopsis leucophaeta*, a marine/brackish water representative of the Dreissenoidea or Zebra Mussels. The species was known from Belgium as early as 1835 and has spread to France, Germany, the Netherlands and now Great Britain (Oliver & Holmes in press).

The tiny RDB3 marine prosobranch, *Paludinella littorina*, has been recorded from a scattering of sites along the south coast between Bembridge and Portland and at a handful of locations along the north and south coasts of the Bristol Channel. Despite several old records for the species from Cornwall there were no previous records for south Devon, however during Channel fieldwork several specimens were found in caves at Seaton in September 1997 (Light & Killeen in press). This is now the westernmost colony along the south coast and we could be optimistic that fieldwork directed towards locating further populations in appropriate habitat might yield more records from southwest England.

At the close of my reporting year, I am encouraged to receive notification that two further sightings of the Mediterranean nudibranch, *Tylodina perversa*, have been made at Hannafore Point in Cornwall at the beginning of February and March 1998. Rather than a single settlement event, it now seems likely that the species has occupied the site

continuously for 15 months (Light, Journal of Conchology 36 p.91).

I end with my usual plea that members should continue to send in their records. Marine recording in the Society has moved on from the era of recording at Sea Area level to a scheme which allows us to plot our information to as fine a precision as 1° of latitude by 1° of longitude. Whilst data from many under-recorded localities are needed to fill the gaps, reiterated records from more popular and regularly visited sites give us valuable information about the stability of species locally or their distributional fluctuations. I would like to extend thanks to all those who have supported marine recording during the year.

# REPORT OF THE HON. CONSERVATION OFFICER 1997–1998

Key items from the 1997–98 year are summarised below.

**Biodiversity Matters** 

• The Conservation Officer attended a conference, 'Rising to the biodiversity challenge - the next five years', a summary of which was included in the Newsletter.

 Several Society members are sitting upon UK Steering groups for a number of the Biodiversity Steering Group's Short List Species. These include groups representing (1) the Vertigo species, V. geyeri, V. genesii, V. angustior & V. moulinsiana; (2) Pseudanodonta complanata and (3) Segmentina nitida and Anisus vorticulus.

• The Society was involved in commenting upon applications for a NERC/Environment Agency Research Studentship/Fellowship aimed at determining the key habitat requirements of the Biodiversity Shortlist freshwater species. The outcome of the 5

applications is awaited.

Molluscan information has been supplied to a number of local and regional

Biodiversity Plans such as those for Durham and West Sussex.

 Several members have been involved on a professional basis with survey and monitoring of Biodiversity Shortlist Species including Anisus vorticulus, Segmentina nitida, Pisidium tenuilineatum, Vertigo moulinsiana, Myxas glutinosa and Margaritifera margaritifera.

Advice and help Has been given to a wide range of individuals and organisations and examples include:

Further advice given to the R.S.P.B. regarding the management of reserves at Surlingham, Norfolk following field visits and a meeting involving representatives

from a range of organisations.

 The Environment Agency (Worthing) were advised on habitat management following monitoring work assessing the impact of maintenance work on a stretch of the River Arun supporting important populations of the Red Data Book species, Pseudamnicola confusa. They were also provided with molluscan information regarding the Sussex Reedbed Habitat Action Plan.

• Information was given to the Environment Agency (Thames Region) on Biodiversity and Red Data Book listed Mollusca in and adjacent to the River Thames. Help was given to an Irish organisation seeking to assess the environmental impact of a

proposed road scheme threatening ancient woodland at Tralee, Co. Kerry.

• Details were supplied to East Sussex County Council of the molluscan interest of the Kiver Ouse corridor.

• Advice was supplied to individuals establishing a Helicella itala survey of Salisbury Plain.

British Wildlife The production of a biannual molluscan wildlife report for this journal has continued.

Joint Committee for the Conservation for British Invertebrates and links with other organisations Membership of the Committee continues providing valuable contacts with other organisations. The Conservation Officer has attended all meetings and chaired one. At the time of writing the JCCBI has been exploring support links with the RSPB and a forthcoming exploratory meeting between both organisations will be attended by the CSGBls President and Conservation Officer.

A number of Society members attended the JCCBI conference on 27.9.1997 titled 'How to give invertebrates a higher profile in conservation'. Some joint field meetings with the

JCCBI and CSGBI are being considered for the 1999 programme.

Conservation work undertaken throughout the Society Many other conservation activities have been undertaken throughout the year by Society members, often in a professional capacity. These are too numerous to mention individually, but range from continued work with the DOMMIC (English Channel) marine molluscan mapping project, molluscan surveys of freshwaters and wetlands throughout the country including work on the rivers Arun, areas throughout the Hampshire basin, Upper Thames & its tributaries, the River Cuckmere and the Somerset Levels.

**Publicity** Members of the Society appeared on regional and national radio and television programmes. These included a feature on the BBC 'Tracks' programme on non-marine snails, an item on the Channnel 4 'Timeteam' programme on Roman Snails and radio features on *Segmentma nitida* on the Somerset Levels.

The Society was involved in providing data, specimens and photographs for the production of a 37p 'special issue' stamp (one of six designs issued by the Royal Mail in their 'endangered Species' special series) depicting the Biodiversity Steering Group Short List' freshwater snail *Segmentina nitida*.

Portland Harbour Revision Order 1996 It was reported in the last Annual Report that Portland Ports Ltd. were trying to gain the management of Portland Harbour and that the outcome of a public enquiry, held in September 1996, was awaited. The enquiry granted Portland Ports Ltd. a management order but a conservation management committee has been established including representatives from English Nature and The Chesil & Fleet Nature Reserve. This will hopefully minimise damaging actions which could endanger the important marine and brackish water Mollusca of Portland Harbour and the adjoining Fleet.

M.J. Willing Hon. Conservation Officer

## **INSTRUCTIONS TO AUTHORS**

Manuscripts should be sent to:

THE HON. EDITOR, DR P.G. OLIVER,
NATIONAL MUSEUMS & GALLERIES OF WALES, CATHAYS PARK, CARDIFF CF1 3NP.
GRAHAM.OLIVER@NMGW.AC.UK

Papers Two copies of text and illustrations should be submitted; one set of illustrations must be good quality originals. Authors should refer to *New Instructions to Authors* in Volume 36, No. 1 as a guide to format. Authors are reminded of the high cost of printing and therefore are expected to write concisely and to make maximum use of page size when designing artwork and tables.

COMMUNICATIONS These are intended to be short notes of an original nature which do not merit the treatment of a full paper. *Communications* do not normally contain any figures, tables or plates and should conform in style to that of recent issues of the *Journal*.

# Journal of Conchology

Vol. 36, part 4, November 1998

PROCEEDINGS

Contents	
PAPERS	
VERDCOURT B. A contribution to the knowledge of the genital anatomy of <i>Zingis</i> species with particular attention to <i>Zingis depressa</i> (Germain) (Pulmonata: Urocyclidae).	1
BOYER F., NEEFS J. & WAKEFIELD A. A new species of <i>Persicula</i> from the Venezuelan region (Gastropoda: Cystisdae).	15
La Perna R. A new Mediterranean <i>Skeneoides</i> (Gastropoda: Skeneidae) from a shallow-water cave.	21
TATTERSFIELD P. A new species of <i>Parennea</i> Pilsbry (Gastropoda: Streptaxidae) from the west Usambara Mountains, Tanzania.	29
Arrébola Burgos J.R. On two Andalusian Oestophora species: Oestophora ortizi de Winter & Ripken, 1991 and Oestophora granesae spec. nov. (Gastropoda: Pulmonata).	35
Communications	
BALDOCK B.M., MALLINSON J.M. & SEAWARD D.R. Observations on extensive, dense populations of the bivalve mollusc <i>Musculus discors</i> (L., 1758).	43
VERDCOURT B. The distribution of <i>Pseudoglessula terrulenta</i> (Morelet, 1883) (Pulmonata: Subulinidae) in Tropical Africa.	46
Lange C.N., Seddon M.B. & Tattersfield P. Gulella Spinosa (Tattersfield, 1998) New to Kenya.	48
KILLEEN I. & LIGHT J. A discovery of Truncatella subcylindrica living in Cornwall.	50
Reviews	52

55

· ·				
	•			
			,	
,				



